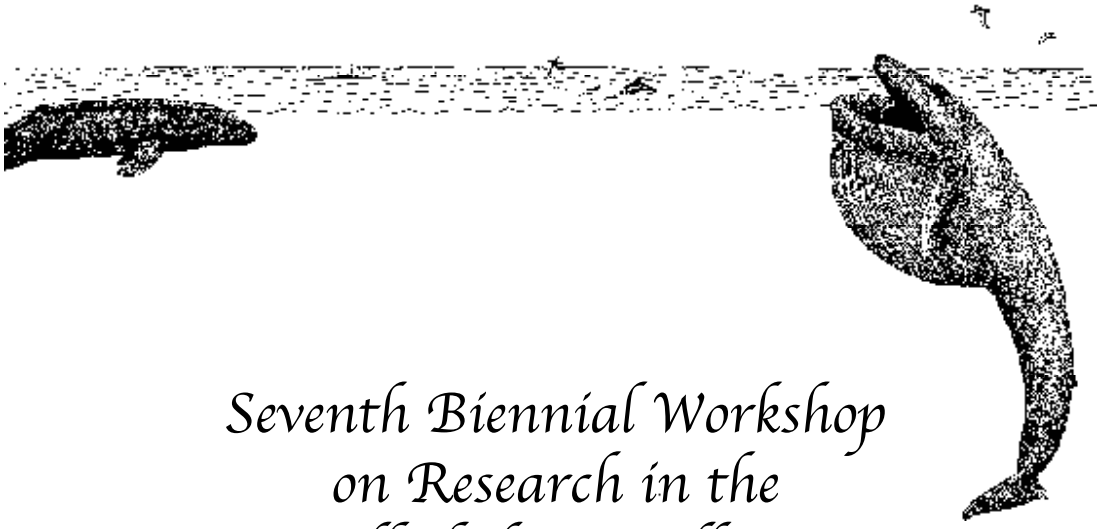


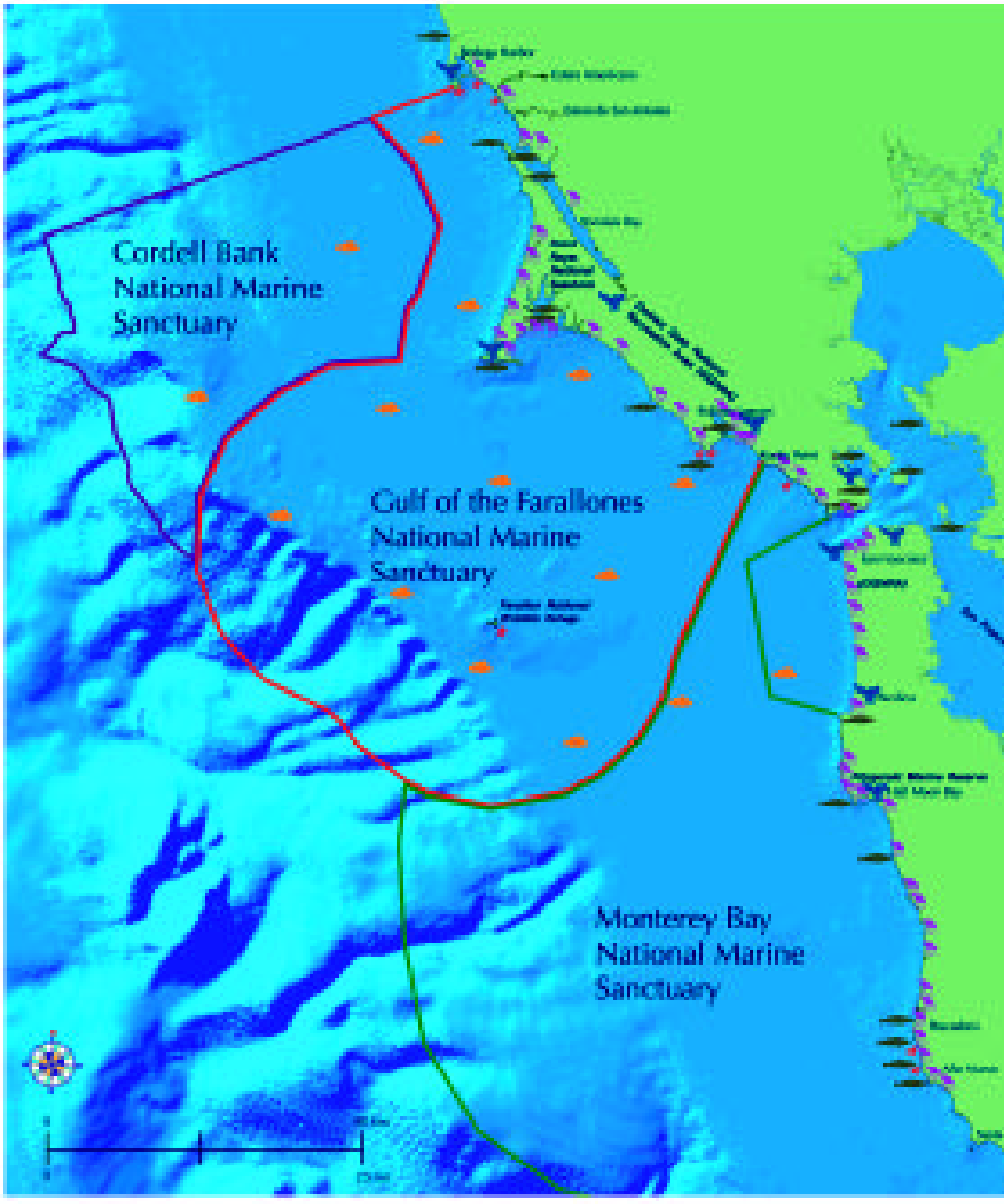
Seventh Biennial Workshop on Research in the Gulf of the Farallones

Changing People's Actions to Improve Our Marine Environment

February 11, 2004

Crissy Field Center in the Presidio
San Francisco, CA

Research and Monitoring Projects of the Sanctuary



MAP KEY:

- *Ecosystem Dynamics Study Stations*
- *Beaches Surveyed Through Beach Watch*
- *Intertidal Monitoring Sites*
- *SEALS Monitoring and Census Locations*
- *Current & Proposed Visitor Centers*

SEVENTH BIENNIAL WORKSHOP ON RESEARCH WITHIN THE GULF OF THE FARALLONES

San Francisco, CA
February, 11 2004

Preface

The Gulf of the Farallones National Marine Sanctuary (GFNMS) is pleased to convene a multidisciplinary workshop on research within the Gulf of the Farallones and adjacent waters. This year we emphasize the need for increased data and information about marine resource management, the integration of biological observations, habitat typing and regional ocean observing systems, fisheries management, marine conservation programs, bay and estuarine research and monitoring, coastal and watershed assessment, and offshore and pelagic community assessment. Our goal is to increase our understanding and protection of the marine and nearshore ecosystems, as well as to increase people's awareness of our marine resources, because it is this understanding that will lead to improvement of the marine environment.

Abstract requests were sent to over 600 researchers and marine educators, private organizations, schools, and public agencies known to be investigating or educating the public about the ecosystem within the Gulf. This year we received over 70 abstracts from a broad range of disciplines: 3 geography and mapping, 4 marine botany, 30 marine ecology and biology, 4 marine education, 5 oceanography, 11 marine ornithology, and 14 resource management. The Workshop is an opportunity for local managers, researchers, and educators to meet people working in other disciplines and to increase communication and collaboration between researchers, managers, policy makers, and the public. We hope you take this opportunity to discuss sharing field expenses, equipment, ship time, and data.

The abstracts in this Proceedings, include projects recently completed, in-progress reports, and projects planned to begin in the near future. The abstracts were not peer reviewed and we hope that you use this forum to critique and contribute to each other's work. Several investigators were not able to attend the workshop, but their abstracts are included in the Proceedings. If you did not receive an announcement of the workshop and wish to be added to the GFNMS research mailing list or if you have comments on this or future research workshops, please submit written suggestions to Jan Roletto, GFNMS, Fort Mason, Building 201, San Francisco, 94123, or e-mail Jan.Roletto@noaa.gov.

During the summer 2002, we began to update our management plan, jointly with Cordell Bank National Marine Sanctuary (CBNMS) and Monterey Bay National Marine Sanctuary. We also established a Sanctuary Advisory Council for GFNMS. The Council allows us to better communicate with non-governmental agencies and is an avenue for involving the public in the development of our management plan. The draft Management Plan focuses on issues such as invasive species, water quality, increasing our understanding of sensitive species and habitats, reducing chronic oil pollution and wildlife disturbance, as well as communicating issues and solutions to our constituents and policy makers. A schedule of the meetings for the Management Plan Review process is included in the Proceedings. For more information on the Sanctuary Council, the Management Plan Review process, or future meetings, see our web sites at:

GFNMS web site - http://www.gfnms.nos.noaa.gov/
Management Plan web site - http://www.sanctuaries.nos.noaa.gov/jointplan/jointplan.html

Future research and monitoring activities within the Gulf of the Farallones appear bright. Our funding level has slightly increased this fiscal year (FY 04). The GFNMS and CBNMS staff have developed and implemented several long-term monitoring programs, which continue to be a priority: rocky intertidal monitoring, shoreline monitoring, wildlife disturbance reduction and monitoring, offshore ecosystem assessment, and restoration projects. These programs are integrated and enhanced in our draft Management Plan. The visibility of the Sanctuary Program has increased over the past several years due to the success of our shoreline monitoring program, Beach Watch, development of our web site, and our annual State of the Sanctuary report. Through our management plan, we have identified partnerships for monitoring and outreach programs that will increase stewardship and protection. We expect to focus on developing new partnerships and strengthening established ones with government and non-government institutions who share an active interest in conserving marine resources and habitats.

Through the Management Plan Review process, the National Centers for Coastal Ocean Service (NCCOS) and our Coastal Services Center developed an ArcView database of current and historic data. Over the next two years NCCOS will continue to populate the database with recently acquired seabird and marine mammal information. We have also developed an on-line data entry system for our Beach Watch survey data. The Beach Watch and offshore biological observations data will be integrated with an ArcView geographical information system and the future Sanctuaries Hazardous Incident Emergency Logistics Database System (SHIELDS). The SHIELDS program will allow for near real-time mapping of sensitive species detected during surveys and will increase access to this information during emergency response events.

We thank the staffs of the GFNMS, CBNMS, and the Farallones Marine Sanctuary Association for their help with organizing the Workshop and soliciting donations for the Workshop: Susan Andres, Maria Brown, Michael Carver, Dru Devlin, April Dewitt, Jamie Hall, Jacqui Hilterman, Adam Hinterthuer, Dan Howard, Ruth Howell, Harriet Lew, Joanne Mohr, Emma Moore, Joe Mortenson, Judith Novak, Shannon Lyday, Carol Preston, Jennifer Saltzman, Mary Jane Schramm, Jennifer Stock, Sage Tezak, Meredith Thomas, and Anne Walton. We also thank the GFNMS and FMSA volunteers who helped with audio-visual needs, reception, and clean up. Pieter Folkens designed the images on the Proceedings cover and travel mugs. Peet's Coffee and Tea provided coffee and tea service. Noah's Bagels, Rainbow Foods, and Safeway donated the morning beverages and baked goods.

Jan Roletto
GFNMS Research Coordinator

Amber Mace
Workshop Coordinator

SEVENTH BIENNIAL WORKSHOP ON RESEARCH WITHIN THE GULF OF THE FARALLONES

Oral Presentations

Coffee and Refreshments	**0800 - 0830**
Welcome - M. Brown	**0830 - 0840**
Opening Remarks - J. Roletto	**0840 - 0850**

Marine Resource Management and Monitoring Programs - Moderator Carol Preston

City and County of San Francisco Long Term Environmental Monitoring Program in the Gulf of the Farallones, Part 1: History and Overview A. Navarret	**0850 - 0900**
City and County of San Francisco Long Term Environmental Monitoring Program in the Gulf of the Farallones, Part 2: Sediment and Benthic Infauna Patterns at the Edge of the Sanctuary M. G. Kellogg	**0900 - 0910**
Wildlife Operations and Adaptations of Traditional Incident Command (or ICS) Structure to Address Areas of Special Significance: A Case Study of the SS *Jacob Luckenbach* and the Gulf of the Farallones National Marine Sanctuary Y. Addassi, J. Buffa, M. Ziccardi, J. Yamamoto, S. Newman, K. Jennings	**0910 - 0920**
Upper Water Column Monitoring at the San Francisco Deep Ocean Disposal Site (SF-DODS) 1996-2001: Six Years of Data on Hydrography, Chlorophyll, Nutrients, Euphausiids, and Fish Larvae West of the Gulf of the Farallones National Marine Sanctuary M. F. McGowan	**0920 - 0930**
MARINe – The Multi-Agency Rocky Intertidal Network A Long-Term Partnership That Works M. E. Dunaway	**0930 - 0940**
Inventory of Point Reyes National Marine Sanctuary S. G. Allen, D. Adams, D. Schirokauer, and B. Becker*	**0940 - 0950**
Tomales Bay Biodiversity Inventory B. Becker, D. George, C. Anastasia, and G. Knoblock	**0950 - 1000**
An Introduction to the Central California Ocean Observing System (CenCOOS) S. Watson	**1000 - 1010**

The SIMoN Website as a Tool for Sharing Monitoring Information **1010 - 1020**
J. Pederson

BREAK **1020 - 1040**

Marine Resource Management, Fisheries Management, and Marine Conservation Programs - Moderator Mary Jane Schramm

Joint Management Plan Review **1040 - 1050**
A. Walton and R. Howell*

Current Issues Facing Our Sanctuaries: The Science and Politics of Sound Stewardship of Marine Ecosystems **1050 - 1100**
R. Charter

Racing for Crabs: Management Options in California's Commercial Dungeness Crab Fishery **1100 - 1110**
C. M. Dewees, K. Sortais, M. J. Krachey, S. C. Hackett, and D. G. Hankin

The Potential for Sea Otters to Drown in Dungeness Crab Traps and a Possible Solution **1110 - 1120**
J. Ames, B. Hatfield, and A. Johnson

Identifying Priority Conservation Areas for the Baja California to Bering Sea Region **1120 - 1130**
L. Morgan

Bay and Estuarine Research and Monitoring

Comparing Effects of Native and Introduced Cordgrass (*Spartina* spp.) on Tidal Marsh Invertebrates **1130 - 1140**
E. D. Brusati and E. D. Grosholz

Preliminary Results for the 2003 Invasive *Spartina* Monitoring Program **1140 - 1150**
K. Zaremba

Implications of Genetic Diversity in Eelgrass (*Zostera marina*) for Ecological Function **1150 - 1200**
A. R. Hughes

Restoration of Native Oyster Populations in Tomales Bay **1200 - 1210**
T. Grosholz, P. Olin, D. Kimbro, and A. Baukus

The Role of the Native California Oyster (*Ostreola conchaphila*) as a Foundation Species and Factors Limiting Its Current Distribution in Tomales Bay **1210 - 1220**
D. Kimbro, A. Baukus, and E. Grosholz

Survey Activities for the Tidewater Goby (*Eucyclogobius newberryi*) in Tomales Bay **1220 - 1230**
D. Fong, T. Moore, and R. Watanabe

LUNCH **1230 - 1400**

Poster Session (During Lunch) **1330 - 1400**

Bay and Estuarine Research and Monitoring- Continued- Moderator Jennifer Saltzman

Foraging Ecology and Demography of the California Least Tern (*Sterna antillarum browni*) in San Francisco Bay **1400 - 1410**
M. L. Elliott, B. L. Saenz, A. Zoidis, and W. J. Sydeman

Influence of Re-Establishing Tidal Circulation on Inlet Geometry, Tidal Prism and Avian Use in Livermore Marsh, Tomales Bay, California **1410 - 1420**
K. Etienne, L. Hammack, E. Blustein, and J. P. Kelly

Coastal and Watershed Research and Monitoring

Comparison of Biodiversity Patterns Among Rocky Intertidal Communities **1420 - 1430**
K. E. Kusic, P. T. Raimondi, A. Kendall, D. Lohse, E. Maloney, M. Williams, and M. Wilson

Predator Diversity and Trophic Cascades in Kelp Bed Ecosystems **1430 - 1440**
J. Byrnes, J. Stachowicz, S. Olyarnik, C. Thornber, R. Hughues, and K. Hultgren

Determining the Geographic Distribution of the WS-RLP, the Causative Agent of Withering Syndrome in Wild Abalone Within the Gulf of the Farallones National Marine Sanctuary **1440 - 1450**
T. T. Robbins and J. D. Moore

On the Limits of Existence: Status of Marbled Murrelets in Sonoma and Marin Counties **1450 - 1500**
C. Strong

Marine Bird Responses to the 2002/2003 El Niño 'Lite' and the 1998-1999 Regime Shift **1500 - 1510**
P. Warzybok, R. Bradley, and W. J. Sydeman

Population Trends of Brandt's Cormorants in the Gulf of the Farallones, California, 1985-2002 **1510 - 1520**
G. J. McChesney, T. B. Poitras, H. R. Carter, M. W. Parker, and P. J. Capitolo

Offshore and Pelagic Community Assessment and Monitoring

Habitat Characterization and Biological Monitoring of Cordell Bank **1520 - 1530**
D. Howard, D. Roberts, and T. Anderson

Side-Scanning Sonar Mapping Along the Fanny Shoals Area, Northern Part of the Farallon Islands **1530 - 1540**
R. J. Anima and J. L. Chin

What Can We Learn About Monterey Bay and Beyond, from an 82-Year Record of Sea Surface Temperature from Pacific Grove? **1540 - 1550**
L. Breaker

Where and Why Does Upwelling Occur? Two Mechanisms Compared North of Pt. Reyes **1550 - 1600**
E. Dever, C. Dorman, and J. Largier

BREAK **1600 - 1620**

Offshore and Pelagic Community Assessment and Monitoring Continued- Moderator- Dan Howard

Aerial Surveys of Marine Birds and Mammals in Central California **1620 - 1630**
L. Henkel, W. B. Tyler, J. Davis, B. Keitt, and T. Hoff

Harbor Porpoise Population Structure and Abundance in Central California **1630 - 1640**
K. Forney

Ten Years of California Sea Lion (*Zalophus californianus*) Strandings Along the Central and Northern California Coast: Changes in Disease Prevalence 1991-2000 **1640 - 1650**
D. Greig, F. Gulland, and C. Kreuder

Current Studies on Diseases of California Sea Lions (*Zalophus californianus*) Stranding Along the Central California Coast **1650 - 1700**
F. Gulland

Abundance, Trends, Population Structure and Movements of Humpback Off California and in the North Pacific **1700 - 1710**
J. Calambokidis, T. Chandler, K. Rasmussen, L. Schlender, and G. H. Steiger

Population Status and Underwater Behavior of Blue Whales Determined Through Photo-ID and Suction-Cup Attached Tags **1710 - 1720**
J. Calambokidis, J. Francis, M. Bakhtiari, G. Marshall, M. McDonald, B. Burgess, E. Oleson, and J. Hildebrand

An Initial View of the Global Stock Structure of Blue Whales (*Balaenoptera musculus*) Based on Nuclear Genetic Variation **1720 - 1730**
C. Conway, L. Lyons, R. Sears, J. Calambokidis, N. Kanda, and B. May

Occurrence of Leatherback Sea Turtles off the Coast of Central California **1730 - 1740**
S. Benson, P. Dutton, and S. Eckert

The GFNMS Visitor Center will be open, please join there to decompress after the workshop and beat the traffic. **1800 - 1900**

*Indicates name of presenter

Poster Presentations

The Romberg Tiburon Center for Environmental Studies: A Center for Environmental Research, Education and Community Outreach

A. Arp

Linking Indicators of Stress with Reproductive Impairment of Crabs in West Coast Wetlands

A. Briden, E. Fairbairn, S. Walsh, T. Visintainer, L. R. Judah, S. Spilseth, G. N. Cherr, and S. G. Morgan

Sex, Status and Sand: California Academy of Sciences Teen Interns Examine Trends of the Pacific Mole Crab (*Emerita analoga*) at Ocean Beach, San Francisco

J. Chu, A. Conrad-Saydah, F. Alfaro, S. Cohen, B. Kwan-Leong, D. Masters, and R. Tom

Mortality of Northern Fulmar (*Fulmarus glacialis*) in California During October 2003

J. T. Harvey, H. M. Nevins1, S. Hatch, J. Adams, J. Hill, J. Ames, J. Parkin, K. Newton, and T. Hass

Environmental Impact of a Submarine Cable: Case Study of the ATOC/ Pioneer Seamount Cable

I. Kogan, C. K. Paull, L. Kuhnz, S. von Thun, E. Burton, H. G. Greene, and J. P. Barry

San Francisco Bay National Estuarine Research Reserve

J. C. Kooser

Inter- and Intra-Annual Patterns of Phytoplankton Assemblages During Upwelling Events off the Coast of Northern California

A. M. Lassiter, F. P. Wilkerson, V. E. Hogue, and A. Marchi

Occurrences of Selected Habitat Forming Deep-Sea Corals

L. Morgan

The SIMoN Website as a Resource for Marine Educators

J. Pederson, C. King, and S. Smith.

Seabirds in an Estuarine Environment: The Story on Alcatraz Island, California

B. L. Saenz, D. A. Gardner, J. A. Thayer, W. J. Sydeman, and D. A. Hatch

Sustainable Seas Student Intertidal Monitoring Project at Duxbury Reef in Bolinas, CA

K. Soave, J. Saltzman, H. Begley, H. Bassett, M. Hester, L. Mann, J. Scott and T. Ulrich

The California Center for Ocean Science Education Excellence (COSEE): Engaging Ocean Science Researchers in K-14 Education

C. Strang

Additional Abstracts Not Presented

Population Trends and Species Distributions of Top-Trophic Marine Vertebrates in the Central California Current 1985-2005
D. Ainley, L. Spear, and C. Keiper

Larval Retention Zones at Headlands: How Do They Influence Onshore Populations?
L. Akins

The Partnership for Interdisciplinary Studies of Coastal Oceans
M. Carr and P. Raimondi

The CSU Center for Integrative Coastal Observation, Research and Education (CI-CORE)
Kenneth Coale, Toby Garfield and the individual institution CI-CORE investigators

Marine Resource Assessment at the Fitzgerald Marine Reserve: Creating a Geographic Information System
A. DeMare

State and Federal Monitoring and Assessment Programs of Interest to California's National Marine Sanctuaries - 2004
R. Fairey

Overview of the Current Monitoring of Harbor Seals (*Phoca vitulina richardii*) in San Francisco Bay, CA
D. Green, E. Grigg, S. Allen, and H. Markowitz

Survey of Discharges into State Water Quality Protection Areas
D. Gregorio

Reproductive Success of Brandt's Cormorants at Three Nearshore Colonies in Central California 1997-2001
N. M. Jones, M. A. Murphy, M. W. Parker, H. R. Carter, R. T. Golightly, and G. J. McChesney

ROV Invertebrate Survey of Southeast Farallon Island
K. Karpov, M. Prall1, D. Sweetnam, A. Lauermann, and J. O'Leary

Documented Occurrences of Bird Species on Tomales Bay and a Protocol for Future Bird Species Inventories
J. P. Kelly and R. W. Stallcup

Locating Marine Reserves Based on Coastal Features: Coupling Ocean Circulation and Larval Settlement Around a Headland
A. J. Mace

Restoring Common Murre Colonies in Central California: An Update
G. J. McChesney, M. W. Parker, S. W. Kress, H. R. Carter, and R. T. Golightly

EMAP/NOAA 2003 Survey of Ecological Conditions of the Western U.S. Continental Shelf, Including Gulf of Farallones National Marine Sanctuary
W. Nelson

Ecological Impacts of Green Macroalgal Mats in Drakes Estero
D. Press

Beached Bird Surveys and Chronic Oil Pollution in Central California
J. Roletto, J. Mortenson, I. Harrald, J. Hall, and L. Grella

Remotely Operated Vehicle Survey of Channel Islands Marine Protected Area
D. Rosen

Feeding and Behavioral Ecology of Whale Watchers with in the Gulf of the Farallones National Marine Sanctuary
M.J. Shamm and J.R. Roos

Joint Management Plan Review 2004 Schedule

Gulf of the Farallones, Cordell Bank,
and Monterey Bay National Marine Sanctuaries

During 2004, the Joint Management Plan Review will be nearing the release of the Draft Management Plan (DMP) and the Draft Environmental Impact Statement (DEIS). Sanctuary Advisory Council meetings include JMPR updates and are important forums to submit public comments on its progress. Please check the agenda prior to each meeting for JMPR- related agenda items. Following the release of the DMP and DEIS, the Sanctuary will host a series of public hearings throughout the region to receive comments on the Draft Plan.

Event	Date	Time	Venue
GFNMS Advisory Council meeting	February 12	9 a.m.-5 p.m.	PRNS Red Barn
CBNMS Advisory Council meeting	March 4	9a.m.- 4 p.m.	PRNS Red Barn
MBNMS Advisory Council meeting	April 2	9 a.m.- 5 p.m.	Santa Cruz
MBNMS Advisory Council meeting	June 4	9a.m.-5 p.m.	Pacific Grove
CBNMS Advisory Council meeting	June 8	9a.m.-4 p.m.	PRNS Red Barn
GFNMS Advisory Council meeting	June 10	9a.m.-4 p.m.	TBD
MBNMS Advisory Council meeting	August 6	9 a.m.-5 p.m.	Cambria
Release of DMP and DEIS	Late Summer 2004	NA	NA
Public Comment Period on DMP and DEIS	Late Summer/ Early Fall 2004	NA	NA
Public Hearings on Draft Management Plan and DEIS	Late Summer/ Early Fall 2004	TBD	TBD
GFNMS Advisory Council meeting	September 9	TBD	TBD
CBNMS Advisory Council meeting	September 23	TBD	TBD
MBNMS Advisory Council meeting	October 1	9 a.m.–5 p.m.	Big Sur
CBNMS Advisory Council meeting	December 2	TBD	TBD
GFNMS Advisory Council meeting	December 9	TBD	TBD
Release of Final Management Plan	Winter 2004/2005	NA	NA

NA- Not Applicable TBD- To Be Determined

For more information and updates, please visit the joint management plan review website at http://sanctuaries.nos.noaa.gov/jointplan/ or contact your local sanctuary office at:

Gulf of the Farallones and Cordell Bank NMS
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Monterey Bay National Marine Sanctuary
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Abstracts

Presented in alphabetical order of first author's last name.

Wildlife Operations and Adaptations of Traditional Incident Command (or ICS) Structure to Address Areas of Special Significance: A Case Study of the SS *Jacob Luckenbach* and the Gulf of the Farallones National Marine Sanctuary

Yvonne Najah Addassi[1], Joelle Buffa[2], Michael Ziccardi[3], Julie Yamamoto[1], Scott Newman[3], Kathleen Jennings[1]

[1]California Department of Fish and Game, Office of Spill Prevention and Response (DFG-OSPR)
[2]U.S. Fish and Wildlife Service (USFWS), Department of the Interior
[3]Oiled Wildlife Care Network (OWCN), Wildlife Health Center, University of California, Davis

From 2001-2002, oiled birds were found along 220 miles of California's central coastline, and Farallon Islands, with more than 2000 birds recovered and transported for care. No significant slicks or other obvious sources of oil were observed. Response activities were developed to address a prolonged wildlife event, rather than proceeding as a typical short term oil spill response. This event was part of a long pattern of repeat "mystery" oil spills in this region that puzzled investigators for 10 years, most believing the oil resulted from illegal dumping; but when the 2001/2002 event extended well beyond the winter season, investigators looked deeper. After an extensive investigation by State and Federal agencies, the sunken vessel, SS JACOB LUCKENBACH was identified. A six month, $19 million salvage, multi-agency response operation was undertaken by the U.S. Coast Guard (USCG) with operations concluding October 2002.

To address the 11-month wildlife response for the 2001/2002 season, the Incident Command Structure was modified to address the unique needs of this event, including; activation and deactivation criteria; weather prediction for oil release and animal stranding patterns; hybridization of field team functions; changing response priorities for key species; and, long-term staffing, communication and coordination challenges amongst the multiple agencies. Due to the sensitivity of the resources at risk on the Farallon National Wildlife Refuge (FNWR), Point Reyes National Seashore (PRNS), and Año Nuevo, a plan was developed to determine what search and collection activities would be appropriate, what procedures would be followed for data collection, and any activation criteria deemed necessary.

Protocols were developed and approved of by an interagency group consisting of USFWS, CDFG-OSPR, NOAA, NMFS and USCG. The plan established that routine oiled bird and marine mammal observations and weekly pinniped surveys were to be conducted. If 20-25 oiled birds or marine mammals (any combination) were observed in a single day, USFWS and PRBO biologists stationed on FNWR will implement “heightened awareness” procedures consisting of more frequent visual monitoring and daily reporting of oiled bird and mammal numbers to the OWCN Response Coordinator, OSPR Wildlife Branch Director, and USFWS. Other “heightened awareness” protocols were also implemented for the mainland and boat operations.

As the response progressed, the regular presence of search and collection teams on public and managed areas of the coast became more noticeable. As a result, a list for agency

notification was developed to assist these agencies with fielding questions from the public. For example, search and collection in the Point Reyes area involved notification to the lead biologist for PRNS as well as the BeachWatch coordinator for the Gulf of the Farallones National Marine Sanctuary. These notifications led to further inter-agency interaction and joint development of additional protocols specifically designed to meet particular species sensitivities in protected wildlife areas.

Although most response organizations are structured to respond to 'batch' spills, with hundreds of aging sunken vessels along the California coast alone and as the continuous release from the *TV Prestige* demonstrated, organizational modifications may be necessary to adequately prepare for and respond to the more unusual, but potentially growing risk of long-term, intermittent releases in the off-shore environment.

Population Trends and Species Distributions of Top-Trophic Marine Vertebrates in the Central California Current 1985-2005

David Ainley[1], Larry Spear[1], and Carol Keiper[2]

[1]H.T. Harvey & Associates, 3150 Almaden Expressway, Suite 145, San Jose CA 95118
[2]Oikonos, P.O. Box 979, Paradise Valley, Bolinas, CA 94924

Since 1985, we have conducted shipboard surveys to assess the distribution and abundance of marine birds and marine mammals in the Gulf of the Farallones, Cordell Bank, and Monterey Bay National Marine Sanctuaries in conjunction with the NOAA-NMFS rockfish assessment cruises. Dramatic changes in the population size of marine birds in the California Current System (CCS) have occurred in response to the recent warm phase (1976-1998) of the Pacific Decadal Oscillation (PDO). More recently (1998-1999), the PDO was hypothesized to have shifted to its cold phase, and while corresponding changes in species' abundances have been detected at the primary productivity and zooplanktonic levels, information has not been forthcoming about responses at highest trophic levels.

In the past, we have published results from our survey effort during 1985-1994 to detail seabird population responses to El Niño Southern Oscillation (ENSO) and longer-term variation in marine climate; e.g. Ainley et al. (1995a,b), Veit et al. (1996), and (Oedekoven et al. 2001). Ainley and Divoky (2001) summarized the years 1970-1998. However, a more recent analysis (NCCOS 2003) of the data that incorporated the most recent survey years (1984 through 2001) indicated a marked response to the hypothesized regime shift by certain species [Black-footed Albatross, (*Phoebastria nigripes*), Northern Fulmar (*Fulmarus glacialis*), Sooty shearwater (*Puffinus griseus*), and Cassin's Auklet (*Ptychoramphus aleuticus*)].

Our data set represents the longest time series of consistently collected data on pelagic and neritic populations of top-trophic vertebrates in the central region of the CCS, and presents a unique opportunity to evaluate interannual and decadal variation in trends in their abundance and distribution. Investigations of ecosystem responses to the PDO (and the more immediate climatic factors that it affects) are an exciting new approach among researchers investigating the CCS. We will continue to conduct these surveys, thereby providing a better perspective on the suspected PDO regime shift. In a way, the proposed regime shift has provided a 'natural experiment' in much the same way that short-term perturbations related to ENSO have allowed much greater understanding of the factors that are important to the population biology of marine creatures in upwelling systems. Currently it is unclear if observed conditions since mid-1998 indicate a decadal change or are a series of weak La Niña or Neutral years (i.e., two of the three ENSO phases). The ability to identify substantial change in ecosystem structure in the dynamic CCS underscores the value and need of continued long-term research. We plan to conduct analyses of these data to assess population status and trends relative to changes in marine climate. Specifically, we will use GIS and generalized additive models to assess distribution and population trends in marine birds and mammals relative to oceanography e.g. sea surface temperature, salinity, thermal gradients, upwelling intensity, and colony-based trends of seabird demography and diets. Our objective is to determine to what extent decadal responses are species specific. Results of this project will contribute greatly to our understanding of decadal population trends in the context of climate change.

We appreciate the logistical support of NOAA and the NMFS, Santa Cruz Lab, in making our project possible.

Larval Retention Zones at Headlands: How Do They Influence Onshore Populations?

Leah Akins

University of California, Davis

Larval retention zones have been identified in the lee of several major headlands along the Pacific coast of North America. However, the effect of the high concentration of larvae in retention zones on benthic populations has not been investigated. In this study, I investigated the benthic and pelagic processes regulating shore crab populations (*Petrolisthes cinctipes* and *Hemigrapsus nudus*) around Point Reyes in central California. Recent studies have suggested that high larval supply can lead to high adult density in recruitment-limited regions; therefore, I expected that shore crab densities would be higher in the retention zone than north of Point Reyes. I conducted field surveys and experiments to investigate the effect of post-larval supply, settlement, habitat quality, growth rate, and predation pressure on crab populations north and south of Point Reyes. Adult densities of *P. cinctipes* and *H. nudus* were not elevated at sites in the retention zone; in fact, *P. cinctipes* density was actually lower. Estimates of growth rate and predation pressure did not explain this pattern. Habitat quality, a strong correlate of *P. cinctipes* density, was higher at the northern sites. Post-larval supply was higher in the retention zone, but onshore settlement was higher at the northern sites. Onshore settlement and *P. cinctipes* density were strongly correlated for the four sites. Post-larvae in the retention zone did not appear to be coming to shore south of Point Reyes; therefore, onshore settlement and habitat quality were more important factors in determining the distribution of shore crabs around Point Reyes than was post-larval supply from the retention zone.

Inventory of Point Reyes National Marine Sanctuary

Sarah G. Allen[1], Dawn Adams, Dave Schirokauer and Ben Becker

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Point Reyes National Seashore is developing an integrated, long-term monitoring program. The goals of the program are to protect, enhance and restore natural processes and biological diversity. Long-term monitoring is important in order to detect changes in ecosystems, to establish empirical limits of population variation, and to provide for protection, enhancement or restoration, where appropriate. The primary objectives are to 1) inventory and monitor park ecosystems for detection of ecosystem changes over time, 2) identify human caused impacts including wildlife disturbance, erosion, invasion of alien species, and degradation of water quality, and 3) adaptively manage the resources based on monitoring results.

In 2004, the Seashore is completing inventories for coastal biological resources, nearshore fish, and sub-tidal mapping. For example, the coastal resources inventory and mapping program is designed to inventory algal plants, invertebrate animals, and map the coastal geology of the park. In 2003, more than 50 miles of coastline in the Seashore and Golden Gate National Recreation Area was mapped, 60 individual segments were studied and delineated, and over 240 high-resolution digital photos of the coastline were taken. San Francisco State University completed nearshore fish inventories in selected rocky zones of the park in 2003.

The park is in the process of completing monitoring protocols for marine components such as salmonids, pinnipeds, western snowy plovers, water quality and weather. These are in draft form and will be finalized and peer-reviewed in 2004. Monitoring of a few of these indicators has occurred over long time periods and monitoring results are guiding management in protection of pinnipeds and restoration of plover habitat. A key aspect of the program is to integrate existing monitoring efforts and to collaborate with partners such as NOAA.

The Potential for Sea Otters to Drown in Dungeness Crab Traps and a Possible Solution

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Sea otters will enter and drown in traps of various designs (Hatfield et al., 2001). The live-fish trap fishery for nearshore rockfish that developed over the past 12 years or so led to concerns that sea otters might be getting trapped and drowned incidentally in this fishery (Estes et al., 2003). Previous experiments conducted at the Monterey Bay Aquarium with live otters, and at the Department of Fish and Game's Marine Wildlife Veterinary Care and Research Center on dead otters, aimed to better understand the magnitude of this potential source of mortality (Hatfield et al., 2001). With the above concerns in mind we began to view with some alarm the large number of sightings of sea otters, during rangewide survey overflights, in offshore habitat where significant numbers of crab trap buoys were also observed. Our assumption is that at least some of these otters are feeding on the bottom where crab traps are set. In this study we tested both Dungeness crabs and sea otters to see what size openings each could transit. The entrance (fyke opening) in several hundred commercial crab traps we examined were consistently approximately 9 inches wide by 4 inches high. The previous work done by repeatedly pulling dead otters of all sizes through parallel bars that were moved closer and closer together, and the present work done where live otters were encouraged to transit smaller and smaller rigid rectangular openings (similar to crab trap openings), demonstrate that sizeable numbers of young independent sea otters (i.e., foraging on their own) are vulnerable to the current 4-inch-high opening in commercial crab traps. Our tests on Dungeness crabs suggest that the entrance to crab traps could be a full inch narrower (i.e., 3 inches by 9 inches rather than 4 inches by 9 inches) without markedly affecting catch. An opening of 3 inches by 9 inches would also result in the exclusion of virtually all independent sea otters.

Side-Scanning Sonar Mapping Along the Fanny Shoals Area, Northern Part of the Farallon Islands

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Side-scanning sonar was used to conduct geologic and habitat mapping of the Fanny Shoals area, the northern extension of the Farallon Islands. Preliminary results show the complexity of the outcropping rock and its relationship to the adjacent shelf. What appears to be folded and offset sedimentary rock with bedding planes, is juxtaposed against a more massive rock probably the granitic rock of the Farallon Islands. The fine-grained sand to the east of the shoal shows sand waves as well as coarse-grained texture adjacent to the rock outcrop. Linear depressions radiate out from the rock areas and traverse the fine sand areas of the shelf. These depressions are floored by a diverse variety of fine to coarse textures. This 2003 data set when coupled with submersible dives and underwater video surveys will give information about the relationship of the substrate to the types of organisms that live in this environment. The survey was conducted during the first week of July 2003, and covered approximately 80 sq. km of Fanny Shoals. Half of the track lines were spaced at 150 meters giving 50 meters of overlap to allow post-processing for mosaicking. A sonar mosaic of the area will give a better overall view of the fine sand contact with the rock environment and the continuity of bottom features. This work was made possible through cooperative efforts of NOAA- Cordell Bank National Marine Sanctuary, Gulf of the Farallones National Marine Sanctuary, the USGS, and Moss Landing Marine Laboratory. The intent of the USGS in 2004 is to undertake side-scan sonar mapping coupled with underwater camera sled surveys of the “flat areas (low relief)” areas of the Cordell Bank NMS, and to finish sonar mapping of Fanny Shoals.

The Romberg Tiburon Center for Environmental Studies: A Center for Environmental Research, Education and Community Outreach

Alissa Arp

Director, Romberg Tiburon Center

The Romberg Tiburon Center for Environmental Studies (RTC) is the off-campus marine and estuarine research and teaching facility of San Francisco State University (SFSU) located 30 minutes north of San Francisco on a stunning, historically rich stretch of coastline in Tiburon. The Center is the only academic research facility situated on San Francisco Bay, one of the largest and most urbanized estuaries on the west coast of the United States. The Bay serves as an ideal laboratory for a broad range of environmental studies and educational programs. Research scientists, SFSU faculty, and students at RTC have contributed significantly to the body of knowledge of marine and estuarine environments, as well as to the future health of the Bay's waters and wetlands. Through the many classes taught on-site, the Bay Conference Center facilities available for public use, and through community outreach programs and partnerships with local museums and non-profits, RTC nurtures both an understanding and a deeper awareness of our local environment.

Tomales Bay Biodiversity Inventory

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We are beginning the second year of a broad biodiversity research, education and public policy initiative in Tomales Bay coordinated and conducted by local researchers, educators, students, and funders. Through targeted biodiversity and habitat data collection and analysis, we seek to mitigate threats to the bay, restore habitats, create stewards of biodiversity, and improve public policy on conservation issues. Currently, funded research is conducted and approved through an RFP process, and all data are being combined into a database that will provide information on exotic species introductions and spread, as well as locating hotspots of biodiversity in the bay. To date, most existing species data has been compiled and in 2003 we funded studies of fishes, algae, invertebrates, and phytoplankton. High school and college students serve as interns with researchers and data specialists. Key outcomes from this project will include an invasive species early warning and removal program, identification of critical habitat for preservation, sustainable use guidelines, and information for science-based public policy decisions.

Occurrence of Leatherback Sea Turtles off the Coast of Central California

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The leatherback sea turtle (*Dermochelys coriacea*) is the largest sea turtle, weighing up to 1500 lbs. Leatherbacks are considered critically endangered due to the demise of once large populations throughout the Pacific Ocean. Past and current threats include intentional harvesting of eggs and adults, and incidental bycatch in fisheries throughout the Pacific Ocean. The leatherback turtle has the most extensive range of any living reptile, performing long migrations between low latitude nesting areas and high latitude foraging grounds, where they consume large quantities of gelatinous prey, such as jellyfish. Two metapopulations exist in the Pacific; a Mexico/Central America nesting population that migrates to foraging grounds offshore of South America, and a western Pacific nesting population that migrates to foraging grounds offshore of North America. The average time to complete a full migration is approximately three years. Leatherbacks are the most commonly seen sea turtle off central California, a region that is strongly influenced by coastal upwelling during early summer. The frequency, duration, and relaxation of upwelling-favorable winds can influence food web development in this region, including the occurrence and concentration of leatherback prey, such as scyphomedusae. Greatest leatherback densities are found offshore of Pt. Reyes, Half Moon Bay, and Monterey Bay. We hypothesize that leatherback turtle abundance is linked to the hydrographic retention of zooplankton and subsequent concentration of scyphomedusan prey in these coastal areas during relaxation of upwelling-favorable winds. Current research involves aerial surveys to assess leatherback abundance and distribution off California, and the attachment of satellite tags to individuals captured off central California, and at nesting beaches in Mexico, Central America, and the western Pacific to document migration pathways and diving behavior.

What Can We Learn About Monterey Bay and Beyond, from an 82-Year Record of Sea Surface Temperature From Pacific Grove?

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Daily observations of sea surface temperature (SST) have been acquired at the southern end of Monterey Bay in Pacific Grove, California since 1919. It is one of the longest oceanographic records off the west coast of North America. The record is examined to determine the major sources of variability in Monterey Bay and beyond, on time scales from seasonal to interdecadal. Various methods of spectral analysis including bispectral analysis and singular spectrum analysis are employed to extract information on the various atmospheric and oceanic processes that contribute to the variability in SST at Pacific Grove. On seasonal time scales, the expected times of seasonal changes are estimated, as well as the impact of intraseasonal oscillations in Monterey Bay. The annual cycle of SST in Monterey Bay is highly asymmetric with seasonal warming occurring during the spring and summer, and cooling in the fall. This asymmetry is primarily due to the influence cold upwelled waters that are advected into the bay during the spring and summer, an observation supported by results from a simple model that combines both local heating and thermal advection. The asymmetry of the annual cycle also contributes to nonlinearity that is responsible for generating a strong semiannual component through nonlinear interaction with the annual cycle. Interannual variability is dominated by El Nino warming events. The results indicate that SST at Pacific Grove is a sensitive indicator of El Nino warming off the central California coast. The primary source of interdecadal variability is the Pacific Decadal Oscillation (PDO) which also is clearly revealed in the record at Pacific Grove. Finally, linear trends were estimated for the entire record (82 years), and for the 72-year period from 1930 to 2001. Although the estimated trend for the last 72 years is not statistically significant, it is in close agreement with the long-term trend for the Intergovernmental Panel on Climate Change (IPCC) record of global surface temperature that spans a period of 136 years. Finally, at seasonal and annual time scales the results of this study are essentially limited to Monterey Bay, whereas at interannual time scales and longer, SST at Pacific Grove reflects variability that is basin–wide, and perhaps global, in scale.

Linking Indicators of Stress with Reproductive Impairment of Crabs in West Coast Wetlands

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Indicators of stress were linked to reproductive impairment of the lined shore crab, *Pachygrapsus crassipes,* in wetlands on the coast of northern California during the summer of 2003. Egg-bearing females were collected and caged at a highly contaminated study site (Stege Marsh, San Francisco Bay) and a less contaminated reference site (Toms Point, Tomales Bay). The diets of crabs were supplemented with local prey and crabs were transported to the laboratory just before embryos hatched. Previous studies on adult crabs from Stege Marsh and Toms Point showed P450 enzymes in hepatopancreas (indicator of organic contaminant exposure) and DNA damage in blood cells of crabs (indicator of expoure to genotoxic stress) from Stege Marsh were high. In the reproductive crabs, embryos weighed less, developmental abnormalities tended to be greater, and hatching success tended to be reduced at the contaminated site. Abnormalities occurred primarily on the outer layer of the brood that came in contact with contaminated sediment and were easily observed in the field using a pocket microscope. Moreover, the positive relationship between reproductive output and female body size was absent at Stege Marsh, indicating that fewer embryos were produced, or more of them were lost at this site as compared to Toms Point. Reproductive impairment due to contaminants in crabs appears to be a simple indicator that can be used in an initial assessment of marsh condition. Since marsh crabs exist on the East and Gulf coasts, they would make excellent model organisms for monitoring the ultimate measure of fitness: reproduction.

Comparing Effects of Native and Introduced Cordgrass (*Spartina spp*.) on Tidal Marsh Invertebrates

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Marshes within the Gulf of the Farallones NMS contain native Pacific cordgrass (*Spartina foliosa*, 1m tall) and an introduced cordgrass (nearly 2m tall) that is a hybrid between *S. foliosa* and a closely-related species (*S. alterniflora*) from the Atlantic coast. Hybrid cordgrass, confined mostly to San Francisco Bay, is an invasive species that covers mudflats needed by wintering waterbirds and displaces native cordgrass. Its rapid spread and the potential for it to invade Point Reyes National Seashore and other outer coast marshes worries biologists who fear it will cause severe impacts to estuaries, including reducing habitat for wintering shorebirds. One major component of the fauna of these marshes are the invertebrates living within the sediment. However, little is known about invertebrate communities associated with either native or introduced cordgrass in California.

We collected intertidal invertebates in 6 marshes with *S. foliosa* and 2 marshes with hybrid *Spartina* (*Spartina alterniflora* x *S. foliosa*) in San Francisco Bay (San Lorenzo and Alameda), Marin County (China Camp, Bolinas Lagoon, Tomales Bay, Drakes Estero), and Bodega Bay between 2001-2003. Densities of invertebrates within native cordgrass were significantly greater ($p<0.05$) than in adjacent mudflats in silt/clay areas, but sandy sites had higher densities in mudflats. This contrasts with hybrid *Spartina* marshes where vegetation contains lower densities relative to adjacent mudflats. Winter densities exceeded summer densities at most sites. Small worms (enchytraeid and tubificid oligochaetes, spionid polychaetes) and crustaceans (Corophiid amphipods) dominated the fauna. Differences in sediment (organic content, bulk density, salinity) may explain some of the variation between marshes. Vegetation and light measurements showed that hybrid *Spartina* greatly reduces light levels compared to native *Spartina*.

These findings indicate that serious changes will occur to the marsh ecosystem if *S. alterniflora* colonizes outer coast marshes. Hybrid *Spartina* changes both marsh structure and infaunal community composition. Small clones of *S. alterniflora* have already been found at several Marin County sites. Managers need to act quickly to contain and control further invasion of *S. alterniflora* and prevent drastic alteration of this critical habitat.

Predator Diversity and Trophic Cascades in Kelp Bed Ecosystems

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Predators eat herbivores and release plants from consumption, resulting in a green world. It's a hypothesis that has generated more than its fair share of controversy. While a number of these so called trophic cascades have been investigated, the generality of this phenomenon is often contested. Empiricists have long relied on a single species creating a dramatic change in community composition. Most ecological communities are composed of a tangled web of weakly interacting species. In these situations, the role of a single predator may be negligible, as it may either be a weak interactor within the system or the herbivory by non-target species may compensate for the loss of the effects of its target prey. Instead, the presence of multiple predator species may be what regulates the amount of top-down control in the system. Drawing from techniques in the biodiversity-ecosystem function literature, we assembled mesocosm communities of herbivores and predators found in and around *Macrosystis pyrifera* beds in the GFNMS. Tanks contained 0, 1, or 3 predator species with the number of predators held constant. Change in kelp biomass was measured and regressed against predator diversity. Communities with higher predator diversity exhibited significantly more kelp growth than single predator tanks. Kelp growth exceeded predictions from additive combinations of predators in monoculture. The mechanism behind this overyielding remains unclear, but our results suggest complementary behavioral responses to different predators from herbivores. For example, while *Cancer productus* may reduce foraging rates of the kelp crab, *Pugettia producta*, their presence may not effect urchins. The presence of sun stars, *Pycnopodia helianthoides*, may affect the foraging rate of urchins, but not kelp crabs. In a tank containing both predators, then both herbivores would then reduce their foraging rates. This not only illustrates the importance of predator diversity to community dynamics, but also importance of community change caused by a combination of behavioral interactions and population regulation through direct mortality rather than population regulation alone.

Abundance, Trends, Population Structure and Movements of Humpback Off California and in the North Pacific

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We have conducted photographic identification of humpback in the Gulf of the Farallones and elsewhere along the US West coast since 1986. Primary objectives of this work have included examining the abundance and trends, movement and migration patterns, and reproduction and mortality rates. Although photographic identification was the primary method used, we also collected skin and fecal samples, made behavioral observations, and measured sizes of whales. Dedicated surveys have been primarily conducted using Cascadia's three 5-6 m RHIBs and on occasion other boats. Collaborating researchers and work from opportunistic platforms provided additional effort and identification photographs especially in Monterey Bay.

From 1986 through 2002 (analysis of 2003 still underway), 1,437 humpback whales have been identified along the west coast with 798 of these having been seen in the Gulf of the Farallones at some point in time. Mark-recapture estimates indicate humpback whale abundance has increased from just over 500 to close to 1,000 animals off California from the early 1990s to 1998, Between 1998 and 1999 there was a decrease in humpback whale abundance of close to 30%, possibly as a result of the 1998 El Nino.

Examination of interchange rates using photographically identified whales have revealed humpback whales along the west coast represent a distinct feeding area with little or no interchange with whales feeding off British Columbia and Alaska. There was frequent interchange however within the boundaries of this feeding area extending from southern California to near the Washington/British Columbia border. The primary migratory destinations for these humpback whales is the mainland coast of Mexico and Central America. Migrations of well over 100 whales have been documented. Recent research we have conducted reveals that the mainland coast of Central America is a more important wintering area than previously thought and is used almost exclusively in winter months by animals coming from the California feeding area.

Cascadia Research is also helping to coordinate an international collaborative research effort on humpback whales in the North Pacific (called SPLASH) which began in 2004 and will provide information on the overall abundance, trends, and population structure of humpback whales in the entire North Pacific. This project is currently funded by National Marine Fisheries Service, the National Marine Sanctuary Program, the National Fish and Wildlife Foundation, and the Marine Mammal Commission with additional support expected from other countries and sources. Photographic identification in GFNMS and along the west coast will be part of this larger effort.

Population Status and Underwater Behavior of Blue Whales Determined Through Photo-ID and Suction-Cup Attached Tags

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We have been conducting photographic identification of blue whales in the Gulf of the Farallones and elsewhere in the eastern North Pacific since 1986 and have also monitored the underwater behavior of blue whales with suction-cup attached tags since 1999. This ongoing research has provided new information on the abundance, movements and feeding and vocal behavior of blue whale.

Through 2002, 1,495 individuals have been photographically identified with 442 seen in the Gulf of the Farallones. Estimated blue whale abundance from mark-recapture has been just over 2,000 with no indication of an increase in the 1990s. These estimates agree with those from line-transect surveys conducted by Southwest Fisheries Science Center. These indicate the California coast including the GFNMS represents an important feeding area in the North Pacific. Photographic matches of blue whale have shown that whales identified off California have been seen as far north as the Queen Charlotte Islands and as far south as the Costa Rica Dome off Central America.

We have deployed three types of instrument packages on blue whales designed to monitor underwater behavior and vocalizations: 1) National Geographic's "Crittercam", which included Hi-8 video camera, hydrophone for recording vocalizations, and pressure sensor to record water depth, 2) Bill Burgess' Bioacoustic Probe that recorded high quality digital acoustic recording, pressure sensor, and, more recently, accelerometers to measure tilt and roll, and 3) WHOI's dTag which provided acoustics, depth, tilt and roll, and bearing. We deployed tags using a pole from a 5.3m RHIB and monitored the surface behavior and movements of whales. Sex and sighting histories of tagged whales were determined from skin samples and individual identification. Deployments were made at multiple locations including the Gulf of the Farallones, Monterey Bay, the Southern California Bight and the Sea of Cortez, Mexico. Tagging in Monterey Bay in 2003 included collaborative research with UCSC and Moss Landing Marine Lab to provide detailed hydroacoustic monitoring of prey fields in and around the whales.

Insights into feeding behavior included: 1) blue whales conduct multiple upward lunges into prey fields, sometimes inverting, 2) blue whales dive deeper (300 m) than had previously been reported, 3) there are clear regional and diel patterns in diving behavior, 4) blue whale pairs do not appear to be cooperatively feeding. Visual, acoustic and tag data, along with gender and sightings histories, provided new insights into the frequency and behavioral context of calling, including: 1) only a small proportion of blue whales are actively producing long patterned calls especially when feeding, 2) most if not all whales that produced long calls were males, 3) even though regular callers dominated the acoustic record, irregular callers may be more common, 4) calls are produced at a fairly consistent shallow water depth.

The Partnership for Interdisciplinary Studies of Coastal Oceans

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Conservation efforts in nearshore marine ecosystems, including the management of fisheries and design of marine reserves, are crucially dependent on understanding the factors that affect the abundance of marine species. In response to the urgency of marine conservation issues and the scale of marine processes, the Partnership for Interdisciplinary Studies of Coastal Oceans (PISCO) was created and funded by a grant from the David and Lucile Packard Foundation with the goal of providing a new model for solving environmental problems faced in coastal waters.

What is PISCO?

Launched in 1999, PISCO has undertaken an integrated, collaborative research approach to understand the critical elements of coastal marine ecosystems. PISCO operates as a consortium of individual researchers and staff people at four universities along the west coast—Oregon State University, UC Santa Cruz, Stanford University, and UC Santa Barbara. In conducting our research, PISCO focuses on a large-scale system—the California Current—that spans the west coast of the United States and includes a biologically complex and diverse community of rocky-shore and kelp-forest communities. It is the intention of founders of PISCO to conduct core biological and physical monitoring of the nearshore portion of the California Current ecosystem over a multi-decadal time period. In addition to the core monitoring and scientific research to understand identified biological processes in this coastal ecosystem, PISCO is dedicated to promoting interdisciplinary training of university students as well as policy-related outreach to the interested public.

The PISCO Approach

Most marine organisms have a bipartite life cycle involving both a pelagic egg and larval stage and a benthic (reef-associated) juvenile and adult stage. The pelagic larval stage is capable of dispersing great distances in the currents, linking populations and communities along the coast. Therefore, to fully understand the ecology of these species, we need to consider both coastal oceanographic processes and reef community dynamics.

The Nearshore Oceanographic Research Program

A range of water conditions, due to prevailing currents, upwelling, El Niño, and La Niña events, affect west coast shores. PISCO has established a series of study sites distributed along the west coast to encompass this range of oceanographic conditions. At each site researchers collect various oceanographic, rocky-shore, and kelp-forest data using a wide array of methods. With the addition of three new oceanography PIs in 2004, PISCO plans to greatly expand and integrate the existing research plan over the coming years.

The Rocky Shores Research Program

Intertidal sites are the focus of both monitoring and experimental programs. All together, PISCO is actively studying over 100 sites from Alaska to Baja, Mexico. We carry out community surveys annually. In addition, we measure key population and community parameters such as recruitment, growth, and predation rates throughout the year. The geographic extent of the intertidal program, combined with nearshore oceanographic data, provides an unparalleled opportunity to generate general models of community organization.

The Kelp Forest Research Program

Over the past several years, the subtidal monitoring program has grown from 8 to 32 sites in central and southern California. We conduct annual community surveys at each of these sites measuring densities of the major macroalgae, macroinvertebrtes, and fishes. The sites are distributed among the various oceanographic regions as well as inside and outside existing marine reserves. Fish recruitment collectors (SMURFs) are deployed at several sites to examine temporal and spatial variation in the delivery of recruiting reef fishes.

The Training Program

PISCO provides hands-on training in ecological methods and interdisciplinary approaches to a range of students from high school interns, undergraduates, graduate students, and post-doctoral researchers. In addition, PISCO sponsors a course out of Hopkins Marine Station that trains students in biomechanical, molecular and physiological ecology. In coming years, PISCO plans to launch two new cross-consortium courses in 1) physical-biological coupling in the nearshore ocean, and 2) marine conservation and policy.

The Policy and Outreach Program

The overarching goal of the PISCO Policy and Outreach program is to share our scientific understanding of the California Current ecosystem with a diverse audience to inform ocean policy, management, and conservation. We cultivate partnerships with parties including other researchers, policy makers, resource managers, resources users, educators, and the interested public. These partnerships are created through two-directional communication. PISCO listens to understand the perceptions and information needs of policymakers, resource managers and stakeholder groups. We then respond with scientific information that enhances their understanding of the science relevant to questions at hand and informs their decision-making. PISCO also provides information and training for our scientists to expand their understanding of current issues in marine policy and management and to develop their communication skill set.

The Future of PISCO

After 5 years in operation, PISCO has been able to achieve many of the goals it set out to: 1) we have developed an integrated consortium of ecologists, oceanographers, geneticists, policy staff and others; 2) we have established hundreds of research sites throughout the nearshore region of the California Current ecosystem; 3) we have successfully trained dozens of young scientists in working collaboratively and interdisciplinary within a complex coastal ecosystem; 4) we have built a solid foundation of partners and informed important policy processes through our policy and outreach program. As PISCO moves into its sixth year, funded on a one-year extension from the Packard Foundation, we are planning for our future in hopes that our aim to continue PISCO over multiple decades will come to fruition.

For more information on PISCO, please visit our website: www.piscoweb.org.

Current Issues Facing Our Sanctuaries: The Science and Politics of Sound Stewardship of Marine Ecosystems

Richard Charter

Marine Conservation Advocate, Environmental Defense

America's coastal waters are the focus of a new level of public attention, with almost daily news stories now appearing about declines in marine life, dangerous levels of mercury in some seafood, damaging cruise ship discharges, adverse impacts of commercial aquaculture, and the dangers associated with planned new industrial activities offshore. The prestigious Pew Oceans Commission released a report during the fall of 2003 proposing several innovative changes to ocean management, and the Presidential Commission on Ocean Policy, or USCOP, is expected to issue its own report to the Bush Administration during February of 2004. In the midst of the growing national dialog over the need for improved ocean policy, the Sanctuary Advisory Councils for the Gulf of the Farallones, Cordell Bank, and Monterey Bay National Marine Sanctuaries have each submitted a draft "Management Plan Update" for public review. Public hearings on these proposed Management Plan Updates are anticipated during 2004, whereupon NOAA's Washington managers will make a final determination which of these Council recommendations to adopt to ensure better management of our Sanctuaries. 2004 will, therefore, likely be a watershed year for the future of each of our California sites.

The National Marine Sanctuaries are viewed as America's crown jewels of the marine environment, but the protection of our Sanctuaries is far from comprehensive, and other environmentally-sensitive U.S. coastal waters face a range of new threats as well. In the House of Representatives, the Committee on Resources has drafted legislative language which proposes to discontinue the 23-year Outer Continental Shelf (OCS) moratorium and reverse the similar "Presidential OCS Leasing Deferrals" which presently protect the U.S. West Coast, the entire East Coast, and portions of Southeast Florida from new offshore oil and gas activities. Should such a legislative provision be adopted by Congress and signed into law by the President, offshore drilling rigs could sprout up along the boundaries of all of our California Sanctuaries. The 2003 Energy bill originally proposed to allow high-intensity seismic survey vessels to set off loud underwater explosions (which can be heard for up to 200-miles underwater) right up to the borders of our Sanctuaries, until this provision was removed by the Congress and the Energy bill eventually was rejected by the Senate. There are indications that the House Resources Committee will, this year try to pre-empt the implementation of future fully-protected marine reserves by codifying into law the so-called "Freedom to Fish Act". The misnamed Freedom to Fish Act would place an unreasonably high burden of proof on agencies wishing to protect critical ocean habitat from extractive activities for the purpose of restoration of threatened marine species. The House Resources Committee also reportedly plans to launch a reauthorization of the National Marine Sanctuaries Act during the 2004 congressional session, a legislative project that will have major implications for our own Sanctuaries over the long term.

Many new kinds of industrial projects now confront our ocean managers. On the U.S. East Coast, a proliferation of offshore wind energy projects have been proposed from Nantucket Island to New Jersey, and here on the coast of Washington State a wave energy prototype is being evaluated by the Olympic Coast National Marine Sanctuary. Liquefied Natural Gas (LNG) terminals and regasification plants are being proposed in Eureka, Ventura, Long Beach, California, and along the coast of Baja California. The final research report on

the long-term impacts of the 1989 Exxon-Valdez oil spill has recently been released, revealing that toxic petroleum contamination still entrained in Alaska's estuarine sediments and rocky cobblestone beaches even now continues to pollute the ecosystem of Prince William Sound. Toxic polycyclic aromatic hydrocarbons (PAH's) - at even very minute concentrations of one part per billion - have been demonstrated to cause life-cycle mutagenic damage to the eggs of Pink salmon in the spill-impacted zone, resulting in smaller salmon returning to the ocean and a diminished survival rate at sea for this key species. Related scientific evidence that some components of spilled oil actually become *more* toxic, not less toxic, as a result of natural weathering are causing researchers to design a 100-year monitoring program for spill-impacted portions of Alaska's coastline. We will explore the implications of these dramatic findings from the Exxon-Valdez incident, and of looming federal legislation, in relation to our own pending stewardship decisions about the marine environment here on the California coast. Offshore oil and gas tracts with a high degree of development interest to the petroleum industry are located immediately adjacent to the present boundaries of all three Central California Marine Sanctuaries, so potential boundary expansion should be part of the Management Plan Update process currently being conducted. In addition, right here in California, severe budgetary shortfalls at the Department of Fish and Game will result in the untimely curtailment of the implementation of the state's landmark Marine Life Protection Act (MLPA), through which local activists have had the opportunity to nominate and pursue designation of regional marine reserve networks in our state waters.

All of these regional and nationwide factors add up to the inescapable conclusion that local researchers and volunteer ocean activists will need to increasingly shoulder responsibility for the protection and restoration of our own marine environment and its resident species, both inside and outside of our Sanctuaries.

Sex, Status and Sand: California Academy of Sciences Teen Interns Examine Trends of the Pacific Mole Crab (*Emerita analoga*) at Ocean Beach, San Francisco

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ABSTRACT- Student interns from the California Academy of Sciences' Careers in Sciences program monitored the Pacific mole crab (*Emerita analoga*) or sand crabs in collaboration with the Farallones Marine Sanctuary Association. These small crustaceans live in the swash zone of the sandy beach habitat. Sand crabs are important in the food web and therefore their status can help indicate the health of the larger environment. The interns are helping the Gulf of the Farallones National Marine Sanctuary by monitoring the abundance and distribution of sand crabs at Ocean Beach in San Francisco, California. Students set up transects perpendicular to the shoreline, collect 10 samples along the transect, measure the carapace length and determine the sex of each crab and check for the presence of eggs. Students monitored June through September, 2003 Trends examined included differences in the gender ratio, size frequency and distribution along the beach. Students also compared their data to other student data taken from other sites in San Francisco and Marin counties during 2001-2003 from the online database at http://www.sandcrab.org. Using comparisons, interns were able to better understand the processes and significance of studying marine species. Implementation of the project was invaluable in aiding the interns in their understanding of the natural sciences and the role of monitoring habitats in environmental health.

The CSU Center for Integrative Coastal Observation, Research and Education (CI-CORE)

Kenneth Coale[1], Toby Garfield[2] and the individual institution CI-CORE investigators

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The CSU Center for Integrative Coastal Observation, Research and Education (CI-CORE) (http://www.mlml.calstate.edu/cicore/) is a distributed coastal observatory dedicated to applied coastal research and monitoring in the nearshore (<100 m water depth) environment along the entire 1200 miles of California coastline. The observatory specializes in three technologies: high resolution in situ temporal time series at all participating CSU coastal campuses and two high resolution spatial observatories, high resolution hyperspectral imaging from aircraft-flown sensors and high resolution seafloor habitat mapping. This presentation will focus on our progress to date in all three technology foci as well as the organizational structure and outreach efforts. Our two hyperspectral data collects in the Monterey Bay National Marine Sanctuary are proving the utility of hyperspectral imagery for routine analyses of, among other monitoring, time-dependent change analysis of shorelines, water quality, harmful algal bloom (HAB) distribution, seagrass and kelp distributions, and shallow water benthic habitats. The seafloor habitat mapping has focused on developing the data necessary to implement a successful marine environment GIS tool for research and regulatory needs. The in situ monitoring implements recommended core measurements by Ocean Observing Systems and Ocean.US, supports site-specific local observations, and provides a framework for the fusion of the three technologies. All of the data and derived products are served to the public through our web sites.

An Initial View of the Global Stock Structure of Blue Whales (*Balaenoptera musculus*) Based on Nuclear Genetic Variation

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We investigated the population structure of the endangered blue whale on a global scale to delineate biological stocks for conservation management. A total of 204 individuals from 14 locations were surveyed for variation using five nuclear markers from the following genes: alpha-L-iduronidase, polymerase beta, acetylcholine receptor, actin, and a gene in the PIM-1 family. Individuals were genotyped using single-stranded conformational polymorphism analyses coupled with direct sequencing of allele variants. A preliminary analysis of allele frequency distribution patterns was used to form five groups for a hierarchical AMOVA analysis: the eastern north and tropical Pacific (EN&TP), containing samples from California, including the Gulf of the Farallones and the Channel Islands (N=41), western Mexico (N=21), Costa Rica (N=14), and Ecuador (N=9); the eastern south Pacific (ESP), Chile (N=16); the western north Atlantic (WNA), primarily eastern Canada (N=38); the Indian Ocean (IND), containing southern Australia (N=8), western Australia (N=15), and Madagascar (N=6); and the Southern Ocean (SO), containing regions designated by the International Whaling Commission as Antarctic Area I (N=1), Area II (N=8), Area III (N=4), Area IV (N=13), and Area V (N=10). The AMOVA analysis over all loci indicated that approximately 9% of the variance was attributable to differences among groups and no variance was attributable to differences among locations within groups. We found that all groups were significantly different from one another in pairwise comparisons, except that the ESP was not significantly different from the EN&TP or the IND. Pairwise comparisons and factorial correspondence analyses showed little difference among locations in the eastern Pacific, although it is likely that California and Chile are separate stocks based on seasonal differences in migration and breeding. The fact that we did not find significant differences between them may be due to lack of power and/or gene flow. Additional samples as well as analyses of additional loci, including mitochondrial DNA, may provide further resolution.

Marine Resource Assessment at the Fitzgerald Marine Reserve: Creating a Geographic Information System

Aura DeMare

San Francisco State University, Master's Thesis (in progress)
Advisor: Thomas Niesen, Ph.D.

The rocky intertidal zone of the eastern Pacific Ocean is a dynamic and diverse marine environment. Both physical and biological processes are extremely influential in shaping the characteristics of the rocky intertidal, and this environment lends itself to intense exploration and use by humans (Ricketts et al., 1985). The James V. Fitzgerald Marine Reserve, located at Moss Beach, California, is a prime example of the diverse rocky intertidal habitat on the Pacific Coast. It was established in 1969, after years of growing popularity and intensification of use. Currently, there are concerns that heavy visitor use may be affecting the community structures found there, and it is necessary to assess the impacts humans may be having on the Reserve (Brady/LSA, 2002). Studies (Piccone, 2000; Heathcote, 2000) have shown that there is a need for more system-wide assessments, which take into consideration a variety of factors (both physical and biological) that may be affecting the health and existence of the animals known to be found there.

A multidimensional approach and the use of tools that provide a broad range of uses for the future management of the Reserve are critical. A Geographic Information System (GIS) can provide useful ways of portraying pertinent information in a spatial format. A recent study by Sanford et al. (2003) concluded that geographic variation in species interactions may have an important role in the dynamics of intertidal communities and future collaboration on a large geographic scale could provide better insight to local ecological phenomena.

The purpose of this study is to explore the use of GIS as a tool for marine resource assessment, habitat mapping, and the potential for long-term monitoring in an effort to establish a database for the Reserve. Using aerial photographs taken at low tide, a basemap will be created and general features of the reef defined. Subsequent ground truthing and data collection using a Trimble Geoexplorer 3 will then refine the basemap. Additional features, such as geologic, watershed, and coastal dynamics, would greatly enhance the database. Spatial analysis may reveal and/or confirm larger scale patterns and influences that have not yet been considered in the management of the Reserve.

The potential use of the GIS for studying intertidal communities will be at both the local and regional scales, opening the doors for more collaborative and dynamic efforts to understand this complex environment. If established properly and thoroughly, this database can be added to over time, making it an extremely valuable tool capable of evolving with acquired scientific knowledge and changing management practices. Users will be able to query, analyze and map data, share data with others, and make better management decisions.

Where and Why Does Upwelling Occur? Two Mechanisms Compared North of Pt. Reyes

Ed Dever, Clive Dorman, and John Largier

Scripps Institution of Oceanography

One of the primary goals of the recent Wind Events and Shelf Transport (WEST) moored field program was to resolve the spatial variability of wind-driven cross-shelf transport. While the near-surface cross-shelf transport is forced by local winds via Ekman transport, the spatial variability of the near-surface transport is less well understood. This spatial variability can cause divergence that leads to upwelling. Two sources of variability in the near-surface cross-shelf transport are: cross-shelf variations in along-shelf wind stress and the shutdown of Ekman transport over the inner-shelf. The shutdown of Ekman transport over the inner-shelf is caused by the merging of the surface and bottom boundary layers.

We designed the WEST moored array to address these sources of variability. The WEST moored array had 5 buoys spaced in close proximity off Bodega Bay. In the cross-shelf direction, one buoy (D040) was placed at the 40 m isobath, the central buoy (D090) was placed at the 90 m isobath and the offshore buoy (D130) was placed at the 130 m bath. Two buoys were also placed on the 90 m isobath approximately 10 km north and south of the central buoy. Each buoy included anemometers, downward-looking Acoustic Doppler Current Profilers, and temperature sensors sufficient to resolve the surface boundary layer.

We compare the wind-driven Ekman transport with the observed cross-shelf transport at the central line between May and August 2001. The Ekman transport is calculated from the wind speed using a bulk formula. The near-surface cross-shelf transport is calculated by vertically integrating ocean velocity observations within a specified surface mixed layer depth.

Wind variation and the shutdown of Ekman transport are important causes of divergence in cross-shelf transport between the inner-shelf and mid-shelf. There is a persistent increase in offshore Ekman transport from the D040 to D130. The regression coefficients of the D040 and D130 Ekman transports to the D090 Ekman transports are 2.11 and 0.58 respectively. That is, the Ekman transport at the mid-shelf (D090) is more than double that at the inner-shelf (D040) and about 60% of that at the outer shelf (D130).

The regression coefficient (0.12) between Ekman transport and surface boundary layer transport at the inner-shelf (D040) site indicates shutdown of Ekman transport adds to cross-shelf transport divergence. That is, the observed cross-shelf transport is much less than the Ekman transport. At the mid-shelf site (D090), this regression coefficient increases to 0.56. Correlation coefficients of surface mixed layer transport with Ekman transport are significant at both locations (0.46 and 0.81 at the inner- and mid-shelf sites respectively).

At the D130, the correlation between Ekman transport and local surface mixed layer transport (0.14) is markedly lower than at D090. This is because the coastal boundary condition begins to weaken at the outer shelf site, and meander of the depth-averaged flow strongly affects the cross-shelf transport. The cross-shelf divergence caused by the depth-averaged cross-shelf flow may be at least partially cancelled out by along-shelf flow divergence, and we have not yet attempted to characterize its contribution to upwelling.

Racing for Crabs: Management Options in California's Commercial Dungeness Crab Fishery

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Dungeness crab support a valuable commercial fishery off the Golden Gate and Northern California, yet in recent decades the fishery has intensified significantly, with most crab landed during the first six weeks of the six-month season. This study of fishermen's operating costs and their opinions of new management measures is intended to support ongoing discussions and decision-making about policy changes that may affect the economics of the fishery. Our survey results show that a majority of fishermen have favorable views of only two of twelve alternative measures (one trap limit for all size vessels and daylight fishing only). However, opinions of these measures vary between owners of different sized vessels. Experiences in other crustacean trap fisheries around the world suggest that simply implementing these two measures may not significantly decrease total trap numbers fished or slow the race for crab.

MARINe – The Multi-Agency Rocky Intertidal Network: A Long-Term Partnership That Works

Mary Elaine Dunaway

Biologist, U.S. Minerals Management Service

MARINe currently provides the direction, funding and oversight of the long term monitoring of 55 established sites from San Diego to San Luis Obispo, including the offshore islands. Another 15 sites have adopted the MARINe protocol in the Monterey Bay Sanctuary and we expect more to follow. MARINe scientists adopted a core protocol to monitor mussels, barnacles, abalone, algae, surfgrass, owl limpets, anemones, and black abalone so that the data collected is consistent among scientists and can be readily compared. Additional protocols have also been identified for other species of interest, even if data for the species are not collected by every field team. Because of the organization and coordination of MARINe agencies, university and private organizations, environmental changes can be analyzed over a broad area in a cohesive manner. One of the more important findings of MARINe was identifying the initial collapse of the black abalone on the islands and mainland. MARINe provided the data needed by the State to determine if closure of the fishery was warranted.

MARINe continues to grow. There are currently 23 partners who sponsor and advise MARINe. They include Federal, State and local agencies, Universities, other research groups and private firms. This year we completed the design of the MARINe database for the core protocol data, and with this completed, we expect that other organizations will join in order to take advantage of the database along the coast. To be a member, a group needs to provide either in-kind or monetary support, and be willing to share their data with the rest of MARINe.

New ventures include new public and private web pages, educational curriculum and a renewed interest in stewardship. The web pages allow MARINe members to share their findings with other researchers and provide the critical link to managers and public. We are currently adding thumbnails of trends for each species monitored so that one can see the status of a species along the coast at a glance. The new education curriculum, Tidepool Math, teaches basic science and math principles through the eyes of a tidepool. The K-8 and High school curriculum allow students to visualize how the math and science they are learning is used by biologists to conduct research along their coast.

Foraging Ecology and Demography of the California Least Tern (*Sterna antillarum browni*) in San Francisco Bay

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The northern-most colony of the endangered California Least Tern (*Sterna antillarum browni*) resides in Alameda Point (the former Naval Air Station, Alameda), San Francisco Bay, California. This population of approximately 280 breeding pairs appears stable (growing at ~10% per year since inception in 1976), but the location of the colony places it at risk from human induced changes in the surrounding urban-industrial marine habitat.

In 2002, we initiated an integrated study of diet and reproductive performance in relation to prey abundance and distribution in San Francisco Bay. The study was designed to help evaluate the potential negative effects of dredging operations occurring in the Oakland Harbor (just north of the Alameda Point colony) on Least tern foraging ecology.

Our objectives are to: 1) observe feeding of fish to chicks at the Alameda Point breeding colony to determine feeding frequencies; 2) collect prey that are dropped at the colony to determine what fish are important to Least terns; 3) collect fecal samples to determine what terns are consuming; 4) conduct near-surface fish sampling during the breeding season to calculate an index of prey abundance and dispersion; and 5) conduct on-water observations of Least terns to investigate where terns forage.

Results indicate that slender-bodied fish are of importance to Least terns in San Francisco Bay. Northern anchovy (*Engraulis mordax*), jacksmelt (*Atherinopsis californiensis*), topsmelt (*Atherinops affinis*), and Pacific herring (*Clupea harengus*) were the most abundant dropped prey specimens collected from the colony in years 2002-2003. Fecal analyses from 2002 samples suggest that northern anchovy and silversides (jacksmelt and topsmelt) are species terns consume most often. Near-shore sampling in 2002 (using a beach seine and neuston net) showed high numbers of northern anchovy, silversides and various goby species. During our off-shore sampling in 2003 (using a purse seine and neuston nets), we caught anchovy and jacksmelt more frequently than other species, and they were distributed all over our sampling area, indicating that these small, schooling fish were readily-available to terns during the breeding season. Observations of foraging Least terns in 2003 illustrate terns foraged more in the shallow, near-shore areas south and southeast of the Alameda Point colony. We will continue this study in 2004 and 2005, placing emphasis on how inter-annual variation in Least tern diet and prey availability effects the population and reproductive dynamics of these endangered terns.

Influence of Re-Establishing Tidal circulation on Inlet Geometry, Tidal Prism and Avian Use in Livermore Marsh, Tomales Bay, California

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Wetland characteristics in Livermore Marsh have been influenced by the construction of the North Pacific Coast Railroad levee (1865 to 1870) and cattle grazing in two small coastal watersheds (1400 acres). In 1983, Audubon Canyon Ranch constructed four ponds and a spillway at the north end of the levee to enhance freshwater characteristics in the lower portion of Livermore Marsh. These activities excluded tidal circulation for 15 years from the 26 acre wetland located at the Cypress Grove Research Center in Marin County CA. During the El Niño winter of 1998, the combination of high-tides and runoff eroded the railroad levee that previously separated the marsh from Tomales Bay.

We documented physical changes in the lower marsh, using detailed topographic surveys of the marsh plain, annual cross-section, top-of-bank and pond surveys to evaluate tide channel development, and monthly measurements of tidal inlet geometry. We used cumulative rainfall measurements to identify three seasonal variations in fresh water influence. During seasonal transitions, we measured the cross-sectional area of the channel inlet during the ebb of Spring and Neap tides. Measurements represented volumes or cross-sectional areas below 3 ft NGVD29 which corresponds to MHHW (5.4 ft NOS) for Livermore Marsh. Comparison of median tide measurements before the rainy season indicated a significant decrease in tidal inlet area although considerable variation occurred throughout the year, depending upon the combination of tidal and freshwater influence. During the five-year period, tidal prism increased and ongoing erosion of tide channels increased tide channel length from 230 ft to 770 ft. Correlations between channel inlet geometry, tide channel volume and tidal prism were compared with mature marsh systems around San Francisco Bay and Tomales Bay. Results indicated that mature Tomales Bay marshes have smaller inlets than would be predicted by regression models from San Francisco Bay. These results probably reflect differences in tidal exposure and the relatively high marsh plain elevations in Tomales Bay due to the levee and highway which impede sediment transport from the coastal watersheds to the bay. We are seeking additional data sets from more comparable coastal marshes in an attempt to identify some principal covariates that may influence the slopes of regression models for each region.

We also monitored vegetation in 1999 and 2003 and conducted eight winter and eight breeding bird surveys each year (1999 - 2003). The results of the bird surveys have been compared with data from the freshwater period (1991-1995). During the freshwater period, Audubon Canyon Ranch identified six Key wetland species including Virginia Rail, Marsh Wren, Common Yellow-throat, Song Sparrow, Redwing Blackbird and Tricolored Blackbird that were breeding in the lower portion of Livermore Marsh. Results of the freshwater surveys have been compared with five years of winter and breeding bird surveys after tidal circulation was restored in the lower portion of Livermore Marsh. More Virginia Rail territories were detected during the freshwater period, while Marsh Wrens remained stable year-round and Song Sparrows reached higher winter and breeding densities during the tidal period. As predicted, winter richness among other wetland species was higher during the freshwater

period although Great Egrets and Black Phoebes increased during the recent tidal period. Fifteen of the 34 selected species held breeding territories during at least one five-year period, and nine territorial species nested in significantly greater numbers during the freshwater period. In spite of the expected decline in use by freshwater bird species, the development of a self-sustaining marsh is expected to support a higher diversity of primary and secondary producers that drive tidal ecosystems.

State and Federal Monitoring and Assessment Programs of Interest to California's National Marine Sanctuaries - 2004

Russell Fairey

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As a cooperative research effort, the Marine Pollution Studies Laboratory (MPSL) was initiated as a collaboration between research scientists of Moss Landing Marine Laboratories (MLML), the California Department of Fish and Game (CDFG), and University of California, Davis. This collaborative team effort now represents the current state of science in pollution investigation and has built a reputation for research excellence in a variety of applied sciences. The primary focus of this collaboration is scientific support for federal, state, and local agencies in need of applied science expertise over a wide range of scientific disciplines. The MPSL/MLML team currently employs a permanent staff of six researchers (Russell Fairey-principal, Cassandra Roberts, Marco Sigala, Mark Pranger, Krista Kamer and Lara Pranger) and regularly employs a number of graduate students during the field season. Field and laboratory operations are conducted from the new MLML facility at 7544 Sandholdt Rd. The following is a brief description of the current major projects administered and conducted by staff at MPSL/MLML and contracted through San Jose State University Foundation (SJSUF).

Western EMAP Project

This is a five year multi-state effort to assess near-coastal ecosystem health of the West Coast (Alaska, Washington, Oregon, California, and Hawaii) according to methods and procedures developed under U.S. Environmental Protection Agency (EPA) Environmental Monitoring and Assessment Program (EMAP). In California, a four year multi-agency cooperative study is managed by the Southern California Coastal Water Research Project (SCCWRP) and includes partners from the State Water Resources Control Board (SWRCB), the San Francisco Estuary Institute (SFEI), and MPSL (MLML, CDFG and UC Davis). The first year effort (1999) was dedicated to a probabilistic survey of California coastal bays and estuaries. The season in 2000 was a cooperative effort with the EPA and National Oceanic and Atmospheric Administration (NOAA), that focused on a probabilistic survey of 200 stations in San Francisco Bay. The 2002 season focused on a probabilistic survey of intertidal wetlands throughout the state, with a special focus in San Francisco Bay wetlands. The 2003 season focused on a probabilistic survey of offshore California (30-120 meters) and included a focus on all National Marine Sanctuaries along the west coast. Planning for 2005 is underway with the focus again on California coastal bays and estuaries for a temporal assessment.

Fish Tissue Monitoring in San Francisco Bay

Based on results from a 1994 Bay Protection and Toxic Cleanup Program (BPTCP) pilot study of fish tissue contamination, a long term monitoring effort of sport fish from San Francisco Bay is being conducted. This work is incorporated as a regular component of the San Francisco Bay Regional Monitoring Program (RMP), which is managed by SFEI. MPSL/MLML is involved in the study design, sample collection, tissue homogenization, and trace metal analyses. This work has resulted in the issuance of fish consumption advisories by the Office of Environmental Health Hazard Assessment, a number of technical reports and conference presentations, and peer-reviewed journal publications (many available through the SFEI website @ http://www.sfei.org/). MPSL/MLML contributed extensively to the 1994,

1997, 2000 and 2003 surveys. Analysis of samples collected for the 2003 is currently underway with results expected later this year. This survey will be repeated in 2006.

San Francisco Bay Marina Survey

San Francisco Bay Conservation and Development Commission are working collaboratively on a pilot marina water quality study. The intent is to establish baseline information regarding pollutants and the resulting condition of marinas through literature review, data compilation and a field survey of four SF bay marina. Field sampling was conducted during the summer of 2003 and sample analysis is currently underway. A final report is expected during the early summer of 2004.

Ballast Water Management Program

Ballast water has been shown to be one of the primary mechanisms for transporting non-indigenous aquatic organisms into California waters. In October 1999, Assembly Bill 703 became law. The Ballast Water Management Act of 1999 established a program to help prevent the introduction of non-indigenous organisms through the discharge of ballast waters into the State's waters and ports. Recently, the State Lands Commission (SLC) and the SWRCB received grant funding to conduct applied research to evaluate the feasibility cost of installing and efficiency of treatment by onboard ballast water treatment technology. In a collaborative effort with the SLC and SWRCB, MPSL/MLML has been contracted to collect and analyze ballast water samples from demonstration project vessels in order to help determine the effectiveness of ballast water treatment system and ballast water exchange methods under operational conditions. four cruises were recently completed on the passenger cruise line vessel Sea Princess and two cruises were completed for evaluating the effectiveness of ballast management systems in container transport vessels (RJ Pfeiffer). This project is a collaborative effort with Dr. Nicholas Welschmeyer from MLML (phytoplankton expertise) and Dr. Steve Bollens from San Francisco State University (zooplankton expertise). Results are currently being reported and should be available within several months.

California Invasive Species Survey

The Ballast Water Management Act of 1999 stipulates that the CDFG conduct appropriate studies necessary to develop a list of non-indigenous aquatic species occurring in the marine and estuarine waters of the state. The CDFG's Office of Spill Prevention and Response (OSPR) and MPSL/MLML will conduct the field and laboratory studies jointly. OSPR has identified seven regions of the state, representing the state's major ports and estuaries, to conduct both field and literature studies on the presence of non-indigenous aquatic species. These areas include: the major ports of San Diego, Los Angeles/Long Beach, Hueneme, Stockton, Sacramento; San Francisco Bay and adjacent waters; Humboldt Bay; and a number of small harbors along the length of the California coast. The survey is primarily an investigation of epifaunal communities, but also includes minor investigations of infaunal communities, plankton communities, and fish communities. This effort includes the participation of the MLML/Benthic Ecology lab and a number of specialized taxonomists throughout the state. A full report on the ISS survey can be found on the CDFG web site- http://www.dfg.ca.gov/ospr/ (second document under 'Information and Services'). Planning is currently underway for a more extensive 5-year follow-up where sample will be collected along the length of California's outer coast and in San Francisco Bay during 2004, 2005 and 2006. A parallel effort will be conducted for the US Fish and Wildlife Service during 2004 in the freshwater areas of the Sacramento/San Joaquin Delta region.

Surface Water Ambient Monitoring Program

The State Water Resources Control Board has established a new program (the Surface Water Ambient Monitoring Program or SWAMP) to implement comprehensive environmental

monitoring in all of California's watersheds. The focus is to provide the information the SWRCB and the Regional Water Quality Control Boards (RWQCBs) need to effectively manage the State's water resources for a wide range of beneficial uses. SWAMP was developed in response to Assembly Bill 982, as it relates to the implementation of the requirements of Section 303(d) of the federal Clean Water Act (CWA), and other applicable federal regulations, and monitoring and assessment programs. SWAMP is a collaborative effort with the SWRCB, RWQCBs, CDFG, USGS and several contractors. MPSL/MLML will be involved with field and laboratory activities, as well as overall data management for the state. Initial fieldwork begin in the spring 2001 and will continue for a minimum of five years. In the San Francisco Bay Region the focus of SWAMP has been on both urban and rural watershed assessments throughout the Bay area.

Areas of Special Biological Significance (ASBS)

The 1997 California Ocean Plan prohibits discharges into designated marine areas of special biological significance. The level of compliance with this discharge prohibition has not been documented for the entire coastline and has now received priority status from the SWRCB. Two years ago an inventory of discharges was completed in southern California by the Southern California Coastal Water Research Project (SCCRWP). Abd last year northern and central California (including the Farallone Islands) was surveyed. MPSL/MLML conducted the field surveys and working collaboratively with SCCWRP on the GIS component of the project. The report is available is available on the SWRCB website at http://www.swrcb.ca.gov/plnspols/oplans/index.html.

Survey Activities for the Tidewater Goby (*Eucyclogobius newberryi*) in Tomales Bay

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Baseline fishery surveys were conducted in 2001 and 2002 to determine the presence/not found status of the federally endangered tidewater goby in waters within the Giacomini Ranch, a future wetland restoration site located at the mouth of Lagunitas Creek in Tomales Bay, Marin Co., California. Additional surveys were conducted from 2002-2003 to determine the presence of the goby in shallow, brackish water embayments within Tomales Bay. Museum records of the tidewater goby are available for both Walker Creek and Lagunitas (aka Papermill) Creek, but recent surveys have not documented their continued existence. A small population of tidewater gobies were found in a tidally influenced slough, Tomasini Creek that drains to Lagunitas Creek. Tidewater gobies were not found in other localities within Tomales Bay, although potentially suitable habitat is available. Efforts are underway to determine the significance of this population through genetic work being conducted by Univ. of California, Los Angeles.

A Review of Recent Information on Abundance and Population Structure of California Harbor Porpoise

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In the North Pacific Ocean, harbor porpoise are distributed widely in nearshore habitats from central California northward through Alaska and as far south as Japan. They are susceptible to gillnet mortality throughout their range. High levels of gillnet mortality in central California during the 1980s and 1990s caused concern, because little was known about population structure, and studies of blubber pollutant ratios suggested limited movement of individuals. For management purposes, central California harbor porpoise (ranging from Point Conception to the Russian River) were considered a separate stock from animals found off Northern California. Recent genetics studies conducted at the Southwest Fisheries Science Center (Chivers et al. 2002) have revealed additional fine-scale population structure of harbor porpoise along the U.S. West coast, based on analysis of mitochondrial and nuclear DNA in porpoises sampled in Monterey Bay, off San Francisco, in Northern California, and in several areas off Oregon and Washington. Beginning in 2002, the U.S. Pacific Marine Mammal Stock Assessment Reports (Carretta et al. 2002) have thus recognized four California harbor porpoise stocks, with boundaries defined on the basis of low-density regions identified during 1988-97 aerial surveys. Updated estimates of abundance (N) and 95% confidence intervals (CI), calculated from aerial line-transect surveys conducted during 1999 and 2002 (Carretta and Forney 2004), for each of the four stocks are: Morro Bay Stock (Pt. Conception to Pt. Sur): N = 1,636 (95% CI = 730-3,183); Monterey Bay Stock (Pt. Sur to Pigeon Point): N = 1,613 (95% CI = 675-3,353); San Francisco-Russian River Stock (Pigeon Point to just north of Pt. Arena): N = 8,521 (95% CI = 4,151-17,495); and Northern California-Southern Oregon Stock (just north of Pt. Arena to Cape Blanco,OR): N = 12,889 (95% CI = 5,789-24,967. The observed genetic differences between harbor porpoises sampled in Monterey Bay and the San Francisco area are particularly surprising, given the proximity of these two regions (about 100km). A low-density region, centered around Pigeon Point and variably found between about Half Moon Bay and AZo Nuevo Island during the 1988-97 aerial surveys, may represent a dynamic boundary between these two central California harbor porpoise populations. Studies of potential links between fine-scale harbor porpoise distribution and oceanographic features are currently underway in Monterey Bay and along the San Mateo County coastline.

Overview of the Current Monitoring of Harbor Seals (*Phoca vitulina richardii*) in San Francisco Bay, CA

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Since May 1998, the Richmond Bridge Harbor Seal Survey has been collecting data concerning harbor seals in San Francisco Bay (SFB). The monitoring was initiated in conjunction with a large-scale seismic retrofit of the Richmond-San Rafael Bridge (RBRB), located in northern San Francisco Bay (SFB), adjacent to the Castro Rocks (CR) harbor seal haul-out site. CR is a primary SFB haul-out site and the second largest pupping site in SFB. The study is monitoring at CR in order to assess any effects that this construction may have on harbor seal haul out behavior and productivity. Both the number of seals utilizing the CR haul-out site, as well as disturbances to the seals, are recorded. In addition, telemetry studies began in 2001 to identify where seals go when they leave the CR haul out site, and to allow detection of changes in movement, foraging and use areas which may be associated with construction activities.

Construction activity began in January 2001. During the first two work periods of construction activity within the immediate area of the CR haul-out site (Aug 2001 – Feb 2002 and Aug 2002-Feb 2003), the total number of seals hauling out on CR did not decrease compared to past years. Nevertheless, we noted a shift in the haul out pattern at CR compared to past years, with an increase in the number of seals hauling out on rocks located farther from the bridge, and a decrease in the number of seals hauling out on the rocks located closest to the bridge. Construction-related disturbances at CR were attributed to two main factors; watercraft in the area of the haul-out site and construction activities such as jackhammering and the movement of cranes on barges near the haul-out site. Overall, 60% of construction-related flushes (disturbances which caused seals to enter the water) were due to watercraft activities. Mean distances at which watercraft caused seals to flush ranged from 114 m (for construction-related motorboats) to 180 m (for larger construction-related boats such as pushboats and crewboats).

To date, telemetry studies of harbor seals tagged at CR have provided important information about the spatial distribution of seals which use CR, and evidence of the importance of the CR haul-out site to breeding and resting seals. As has been seen in other telemetry studies, foraging/use areas of many tagged seals were located in close proximity to the CR site (generally <5 km), and many tagged seals displayed strong site fidelity to CR for the duration of tag attachment. Although highly preliminary, analysis of the mean distance from CR as a potential indicator of shifts away from the RSBR construction site revealed no consistent trend toward use of in-water areas farther from the bridge. Seals tended to be located farther from the bridge during the first year of construction (2001), perhaps in response to this novel disturbance source. However, other factors may influence seal use areas year-to-year, and additional data and analyses are needed to resolve these questions.

In light of the results gathered to date, we recommend that watercraft travel parallel to the haul-out site rather than toward the haul-out site, as this orientation will likely elicit fewer disturbances. In addition, when possible, watercraft should maintain a slow steady speed when traveling near the site, to avoid disturbances associated with erratic boat movements and

boat wakes. Finally, boats should not travel close to the haul-out site unless necessary. Continued monitoring of the CR harbor seal haul-out site throughout the retrofit work is important in order to properly assess what impacts the work has on the SFB harbor seal population and to measure thresholds in seal response to human-related activities.

Survey of Discharges into State Water Quality Protection Areas

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The California Ocean Plan, adopted by the State Water Resources Control Board (SWRCB), is the water quality control plan for protecting ocean waters of the State of California. The Ocean Plan designates thirty-four Areas of Special Biological Significance (ASBS) along the California coast. ASBS are defined as those areas designated by the SWRCB requiring protection of species or biological communities to the extent that alteration of natural water quality is undesirable. The marine biological communities in ASBS are protected from water pollution because of their value or fragility. Except under certain limited and temporary conditions, the Ocean Plan prohibits discharges into ASBS.

Assembly Bill 2800, the Marine Managed Areas Improvement Act created a system of six defined categories of Marine Managed Areas, one of which is "State Water Quality Protection Areas" (SWQPAs). Effective January 2003, all 34 ASBS were reclassified as SWQPAs. According to AB 2800, in SWQPAs "point source waste and thermal discharges shall be prohibited or limited by special conditions. Nonpoint source pollution shall be controlled to the extent practicable."

A survey was performed by the Southern California Coastal Water Research Project (SCCWRP), under contract to the SWRCB, to identify discharges from both point and nonpoint sources that enter SWQPAs. The survey report was issued in July 2003 and the associated data are available in Geographic Information System (ESRI ArcView) format.

There are five SWQPAs within the Gulf of Farallones National Marine Sanctuary. These are the Farallon Islands, Point Reyes, Duxbury Reef, Double Point, and Bird Rock. Of these, Duxbury Reef had the largest number of discharges identified. Ten surface discharge locations were identified. Of these four were small storm drains from private residences, and one larger outfall was characterized as a municipal storm drain from a parking lot at Agate Beach. In addition, there were 18 natural streams or gullies identified, some of which may carry nonpoint source pollution from upstream into the SWQPA. One in particular, Alder Creek, drains a residential district of Bolinas, and therefore is likely to carry urban runoff into the SWQPA. One groundwater seep was described as possibly being contaminated due to its position below homes on the bluff.

Ten Years of California Sea Lion (*Zalophus californianus*) Strandings Along the Central and Northern California Coast: Changes in Disease Prevalence 1991-2000

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Stranded animals offer a unique sample of relatively inaccessible wild animal populations that are more likely to be diseased than free swimming animals and are easy to examine thoroughly. Diseases in marine mammals may reflect environmental changes such as pollution and global warming. To detect spatial and temporal trends in prevalence of such diseases, and to detect risk factors for observed diseases, we reviewed records for 3720 California sea lions that stranded live from 1991 through 2000 along the central California coast. Reason for stranding was determined from a combination of clinical examinations, hematology and serum biochemistry, radiography, gross necropsy, histopathology, microbiology, and biotoxin assays. Over 10 years, malnutrition was the most common reason for stranding (32%), followed by leptospirosis (27%), trauma (18%), domoic acid (9%), and cancer (3%). Strandings caused by malnutrition were greatest during the El Niño events of 1992, 1993, and 1998, while strandings caused by leptospirosis accounted for over 60% of strandings in 1991, 1995, and 1999. Although domoic acid was first reported in California sea lions in 1998, there was a small stranding event in 1992 that, based on clinical examinations and histopathology, we now suspect was caused by domoic acid. The observed prevalence of cancer among stranded animals has remained constant over the past ten years at 3%. Stranding data contain inherent sampling biases: reporting effort is not equal (greater numbers of animals are reported from accessible coastal areas that are heavily populated by humans); and, because the animals are not a random sample of the population, numbers of stranded, diseased animals cannot be used to infer disease incidence in the population as a whole. Despite these biases, we believe that long-term analysis of stranding data can give indications of disease trends in wild populations.

Restoration of Native Oyster Populations in Tomales Bay

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Historically, native oysters *Ostreola conchaphila* comprised an important commercial fishery and were likely an important structuring component of native benthic communities. Despite a respite from commercial fishing for nearly 100 years, native oyster populations have not returned to what has been viewed as their likely former abundance. The primary goal of this project is to develop methods on a pilot scale that could be used to enhance native oyster populations in Tomales Bay and to assess what might be limiting the recovery of the populations that remain in the bay. Using commercially purchased oyster shell, we have established experimental racks (approx. 1m x 1m x 0.5 m) of oyster shell that provide hard substrate in areas where this may be limiting recruitment. We established replicate arrays that included 4 single racks and one cluster of four racks to compare the effects of the spatial extent of substrate provision. We also quantified the effects of the racks on the recruitment of native oysters on standardized PVC tiles as well as oyster shell. We measured the abundance of introduced predators associated with the oyster racks and tested the effectiveness of experimental predator removal. Based on recruitment results from 2002, variation in recruitment was highly variable around the bay with high levels at western and mid-bay sites, and poor recruitment in the upper bay, particularly on the eastern side. Unfortunately, rates of recruitment throughout the bay were negligible during 2003, so the success of our experimental arrays for enhancing recruitment remains uncertain. Rates of predation by oyster drills and green crabs were both size specific and consistent with declines of juvenile oysters in lab and field experiments. Densities of predators associated with oyster shell racks were similar to densities associated with natural oyster populations, thus introduced predators may continue to be an obstacle to restoration. We were successful with experimental predator reduction and found significantly reduced green crab densities after only a few days of removal. Despite our initial successes, the full effects of using oyster shell racks to locally enhance the recruitment and survival of native oysters remains to be determined.

Current Studies on Diseases of California Sea Lions (*Zalophus californianus*) Stranding Along the Central California Coast

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Two common health problems observed in California sea lions that strand along the California coast every year are cancer and domoic acid toxicity. Recent progress in collaborative studies on these two diseases will be summarized in this talk.

Urogenital cancer occurs at a high prevalence, with approximately 17 % of adult animals examined at post mortem affected. Using polymerase chain reaction (PCR) amplification, an association between otariine herpesvirus 1 (OtHV-1), a novel gamma herpesvirus detected in California sea lions, and neoplasia provide evidence of an infectious component to the development of this urogenital cancer. OtHV-1 was detected in 100% of the tumor bearing animals (9/9 females, 6/6 males). The virus was most often found in pelvic and retroperitoneal tissues, which are the areas of heaviest tumor involvement, specifically the vagina (78%), prostate (80%) and lumbar lymph nodes (60% males, 78% females). Lumbar lymph nodes are often effaced by metastatic carcinoma. The virus was found sporadically in tissues from the anterior regions of the sea lions (pharynx, tonsil). A survey of 42 free-ranging, apparently healthy, adult females on San Miguel Island detected OtHV-1 in eight (19%) of the vaginal samples, but in none of the pharyngeal swabs nor in peripheral blood mononuclear cells. These data suggest OtHV-1 is sexually transmitted on rookeries. OtHV-1 likely acts in synergy with other mutagenic cofactors such as environmental contaminants to which sea lions are exposed during all life stages. Furthermore, a genetic component to the pathogenesis of this disease is likely, as sea lions with cancer are significantly more inbred (as measured by variability at 11 microsatellites) than sea lions dying from other causes.

Domoic acid is a neurotoxin produced by several species of diatom in the genus *Pseudo-nitzschia* that was first identified as a cause of marine mammal mortality in 1998. Since then, regular mortality events have occurred in a variety of marine mammal species off California, and exposure to high doses of this biotoxin is clearly fatal. The effects of sub-lethal doses, however, are still unclear, and are the focus of current investigations. Between May 1998 and July 2002, 128 adult female sea lions stranded live along the California coast showing signs typical of domoic acid poisoning (ataxia, seizures, coma). During rehabilitation, 63 of these sea lions aborted, 23 gave birth to live premature pups that subsequently died, and 13 died and were pregnant at the time. Domoic acid was detected by receptor binding assay and high performance liquid chromatography with mass spectrometry in amniotic fluid from five sea lions that aborted, and from stomach contents and urine of five pups. These results indicate that domoic acid can cause reproductive failure in California sea lions. Sea lions that have survived rehabilitation after domoic acid intoxication have re-stranded and had intermittent seizures, despite domoic acid being cleared form the body. Current studies using magnetic resonance imaging (mri) of brains of live animals showing chronic seizure activity followed by telemetry are investigating the long term effects of domoic acid poisoning on sea lion health.

Mortality of Northern Fulmar (*Fulmarus glacialis*) in California During October 2003

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During October 2003, we documented an unusual mortality of Northern Fulmar (*Fulmarus glacialis*) in central California with at-sea surveys, beached bird surveys, and necropsies. In Monterey Bay, we recorded extremely high deposition of dead fulmars on beaches (mean = 12.8 ± 3.2 SE birds km^{-2}, range = 0.3 – 25, n = 10 beaches), and observed high densities of live fulmars at sea (mean = 14.0 ± 4.7 SE birds km^{-2}, range = 2.4 – 40.1). We conducted post-mortem examinations of 186 fulmars to determine age, colony of origin, and probable cause of death. Necropsies indicated 96% of birds examined were hatch year (67 M, 65 F, 46 U) and 4% were after hatch year (3 M, 2 F, 3 U) based on molt and bursa. All birds had small, undifferentiated gonads (male, mean length [± SD] = 3.0 ±1.3, n = 69; female, mean largest follicle = 0.03 mm, n = 66). The proportion of color morphs, 92% dark and 8% light, suggest birds originated from colonies in the Gulf of Alaska (GOA). Bill measurements were similar to those of the Semidi Islands, AK; the smallest fulmars in the North Pacific. These findings were corroborated by concurrent studies of satellite-tagged fulmars which showed movement of fulmars from the Semidi Islands to central California. Fulmars were in poor body condition as evidenced by reduced body mass (male, mean = 453 ± 60 g, n = 32; female, mean = 383 ± 42 g, n = 41), atrophied muscles and livers, and no subcutaneous fat reserves. Stomachs were virtually empty, containing few squid beaks and plastic fragments. No disease factors were identified in this mortality event. We suggest starvation is the main cause of death; young birds may have been disproportionately affected because they did not have enough energy reserves to buffer against food limitations. Persistent storms in the GOA may have contributed to this starvation event, either by preventing foraging or reducing prey availability during their southerly migration.

A June Anomaly for Great White Shark (*Carcharodon carcharias*) Attack Frequency in the Eastern North Pacific

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The objective was to evaluate the widely held presumption that Eastern North Pacific white shark attack frequency is related to level of human water-related activity. (J. McCosker provided the necessary white shark attack data for the Eastern North Pacific from 1950 to 2003). If this presumption is true, then June attack frequency (3) should be greater that of November (6), but the opposite is true. Twice as many attacks occur in November - so primary causality for white shark attack frequency seems unrelated to the level of human water-related activity because June has the lowest attack frequency of any month (3). The probability that this June anomaly is due to a non-random variable was tested by the cumulative binomial probability test and found to be statistically significant (P<. 05). The highest numbers of attacks have occurred in September (18) and October (17), but human water-related activity is not five times greater than in June (3) as the hypothesis would predict. The June anomaly can only be explained by one of two possibilities: either white shark populations (near human activity) are reduced in June - or else they have different behavioral patterns in June. It is unclear why 3,000 swimmers at a beach that once had 1,500 would result in a doubling of the probability of attack. Once a certain threshold of human activity occurs it seems more likely that local shark attack probability will level off despite further local activity increases. A speculative possibility is that in June female appetites are suppressed for pupping, June shark attacks might then be rare. Other lamnid sharks have been found to have their appetites suppressed when pupping; so it is reasonable to hypothesize seasonal female white shark appetite suppression. Large female sharks are reported to aggregate close to shore. If they then exclude males and non-suppressed sharks the loss of many or most large female sharks in the 1980's and 1990's may have lead to the spike in June attacks if they were then able to access near shore habitat that large females had excluded them from prior. While the data tends to deny the presumption that human water-related activity is a primary factor for white shark attack frequency, it does not invalidate it because unrecognized factors may account for the June anomaly. The frequency of June attack has spiked in the past ten years, suggesting that some variable has recently changed. The causality of the June anomaly however, is entirely unknown.

Shark Predation Upon Juvenile Harbor Seals Inside the Harbor at Bodega Bay California

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The purpose of the study was to confirm shark predation on juvenile harbor seals inside of the harbor at Bodega Bay California. Juvenile harbor seals aggregate inside Bodega Harbor in April. A favored haul out utilized solely by juveniles in spring is well inside the harbor near the cypress campground of Doran Regional Park. By June some are clearly emaciated. Shark predation on juvenile harbor seals begins in May, but many more juvenile seals are found sick or dead from apparently natural causes than are discovered with signs of shark predation. Most evidence for juvenile harbor seal predation is found on the outer beach, suggesting that most predation events taking place outside the harbor. Some however is found well inside, suggesting predation events inside the harbor because the depositional pattern is tightly concentrated. The turn just inside of the Coast Guard moorings seems to be the probable site for most of these events. This channel is 3-6 meters in depth. White sharks have been commonly reported in constrained bay and harbor waters elsewhere but except for the two attacks on humans that occurred inside San Francisco Bay (Alameda 1926 and Baker Beach 1959) and sightings within gray whale calving lagoons in Baja, white sharks are apparently not reported inside protected bay waters within the Eastern North Pacific. Four seal lions and a harbor seal killed or injured by sharks have been reported inside San Francisco Bay, some from Alameda. It is unlikely that the Alameda carcasses washed in from beyond Point Bonita, so these are evidence for white shark incursions and predation within San Francisco Bay. Surveys were conducted for pinniped carcasses on the inside and outside beaches at Doran Regional Park, Bodega Bay California mornings and evenings in April and May 2003. Fresh pinniped carcass fragments were found on three of these dates, one included a portion of a juvenile harbor seal head sheared near the sagittal crest of the skull. Species and cause of mortality are otherwise unconfirmed, but all are thought to be harbor seals. All events occurred at night. Depositional patterns suggest the source for pinniped carcass fragments for two of these events was perhaps .5 km. inside the harbor, near the Coast Guard moorings. The other likely occurred very near the harbor entrance. A large shark was closely observed feeding on a sea lion by the vessel Jaws just within the harbor entrance. During the early summer of 2000 shark predation on an unidentified pinniped was observed immediately next to the Coast Guard moorings. A large white shark was observed within the inner harbor on September 28, 1984, also near the Coast Guard moorings, so upon some occasions large white sharks enter into the harbor, occur at least as far in as the Coast Guard moorings. The source of the shredded pinniped carcass fragments found on beaches is unconfirmed but thought due to shark predation. In addition to the white shark, two shark species reported as pinniped predators are also present in Bodega Bay, the sixgill shark (*Hexanchus griseus*) and the sevengill shark (*Notorhynchus cepedianus*).

Aerial Surveys of Marine Birds and Mammals in Central California

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Since the 1970's, aerial surveys have been used to quantify the spatial and temporal distribution of marine birds and mammals in coastal waters of California. During the past decade, aerial surveys of marine birds and mammals have become a significant component of oil spill response strategy, providing near real-time data on the abundance and distribution of vulnerable species at sea. Aerial observers can quickly locate areas of high potential impact and provide information necessary to direct response efforts. In California, rapid response at-sea surveys are conducted by the University of California Santa Cruz (UCSC) aerial survey team under contract with the California Department of Fish and Game Office of Spill Prevention and Response (OSPR). Since its inception in 1994, the UCSC survey team has responded to six oil spills and participated in numerous spill drills. The UCSC survey team also conducts bi-monthly training surveys in state waters. We have flown over 100 surveys, covering thousands of km, and recorded tens of thousands of bird and mammal sightings. These distribution and abundance records comprise a significant data set that provides historical perspective and can be used for management and spill response decisions. Survey coverage has been heaviest in the Monterey Bay National Marine Sanctuary, but surveys have been conducted in the Gulf of the Farallones National Marine Sanctuary as well, most recently in conjunction with salvage of oil from the Jacob Luckenbach. Opportunities exist for collaboration between the UCSC survey team and other researchers for coordinated ecosystem studies.

Habitat Characterization and Biological Monitoring of Cordell Bank

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Cordell Bank National Marine Sanctuary in partnership with the National Marine Fisheries Service (NMFS) in Santa Cruz, United States Geological Survey (USGS), and the California Department of Fish and Game (CDF&G) has initiated a long-term study to classify habitats and monitor fishes and macro-invertebrates on and around Cordell Bank. In the fall of 2002 and 2003, underwater surveys have been conducted to characterize habitats and quantify fish and invertebrate abundance. Surveys were conducted using direct observation and video transect methods from the two person research submersible Delta. The Bank has a diversity of habitats, which include high relief rock pinnacles, flat rock, boulders, cobble, sand, and mud. Rockfishes (*Sebastes*) are the dominant group of fishes observed, accounting for over 90% of the enumerated individuals. A summary of this work and plans for future activities will be presented.

Implications of Genetic Diversity in Eelgrass (*Zostera marina*) for Ecological Function

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Seagrasses and related aquatic vegetation have declined extensively in the U.S. and worldwide in recent years due to anthropogenic effects such as habitat degradation and reduced water quality. In light of this decline and the recognized importance of eelgrass (*Zostera marina*) populations to the overall health of coastal systems, there is a significant need to understand the dynamics and genetic structure of these populations. Furthermore, due to the priority of these systems for restoration and conservation projects, research examining the role of genetic diversity in ecosystem function is vital to ensure the success of these attempts and the future health of *Z. marina* populations.

To assess the importance of within species diversity for community structure and ecosystem function, I will address the following objectives: 1) Establish baseline data regarding patterns of genetic variation within and among three eelgrass populations in GFNMS using molecular markers previously identified for *Z. marina*; 2) Investigate the effects of varying levels of genetic diversity on ecosystem variables such as eelgrass shoot density, flowering shoot production, and epiphyte and invertebrate biomass. Ultimately, the results of this study and related experiments can be utilized to plan and evaluate eelgrass restoration efforts in order to minimize changes in the overall genetic composition of eelgrass populations and maximize the success of transplant efforts.

To evaluate whether there is a relationship between genetic diversity and ecological variables in the field, I surveyed three eelgrass populations in GFNMS (Clark Road, Blake's Landing, and Cypress Grove Preserve). At each site, I created one transect at each of three tidal levels: high intertidal (> 0 m MLLW); low intertidal (-.5 – 0 m MLLW); and subtidal (< -.5m MLLW). Along each transect I established four $1m^2$ quadrats, two along either edge of the bed and two in the center of the bed. I randomly collected 25 tissue samples from each quadrat in the June 2003 for genetic analyses using DNA microsatellites. In addition, I measured shoot density, flowering shoot density, and epiphyte biomass in each quadrat in January 2002 (two sites only), August 2002, January 2003, and July 2003.

The genotypic diversity per quadrat (i.e., G:N ratio) is defined as the number of distinct genotypes identified per total number of ramets sampled. In a complementary study in Bodega Bay, my analysis of samples from 36 quadrats at five microsatellite loci reveals between one and twelve distinct genotypes per quadrat, corresponding to a range of G:N ratios from .06 to .75. I am currently completing the extraction, amplification, and sequencing of the samples from GFNMS; once the genetic analyses are completed, I will statistically analyze the relationship between small-scale genetic diversity (i.e., G:N ratio) and shoot density, flowering shoot density, and epiphyte biomass using multivariate analysis of variance. In addition, I will generate estimates of bed-wide diversity for the GFNMS populations and use regression analysis to evaluate whether there is a predictable relationship between overall site diversity and ecological variables.

Reproductive Success of Brandt's Cormorants at Three Nearshore Colonies in Central California 1997-2001

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As a component of research and restoration efforts focusing on Common Murre (*Uria aalge*) populations, Brandt's Cormorant (*Phalacrocorax penicillatus)* breeding success was monitored for five years (1997-2001) at three locations along the mainland of central California: Point Reyes Headlands (PRH), Devil's Slide Rock and Mainland (DSR), and the Castle Hurricane Colony Complex (CHCC). Productivity varied widely between colonies and years, but on average was highest at PRH and lowest at CHCC, similar to patterns in murre productivity. The most dramatic differences were recorded during the El Niño year of 1998. The timing of breeding followed a latitudinal trend; cormorants in the most northerly colony (PRH) at latitude 37°59'69"N layed latest in all years, and those in the most southerly colony (CHCC) at latitude 36°22'49"N layed earliest in all years but 1998. At CHCC and PRH the locations of groups of breeding cormorants varied from year to year at each colony. Differences in reproductive success were detected when subcolonies were compared within colony complexes. Such variation suggests a need for broad scale monitoring efforts when attempting to assess Brandt's Cormorant population parameters.

ROV Invertebrate Survey of Southeast Farallon Island

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In September 2000 video transect and quadrat sampling were conducted using a Deep Ocean Engineering Phantom HD2 + 2 remotely operated vehicle (ROV), equipped with a color video camera and tracked by a surface towed Trimble GeoExplorer II GPS receiver and a ORE (Ocean Research Equipment) Trackpoint II ultra short baseline acoustic positioning system. Parallel diode lasers (10 cm apart) were used to measure abalone and sea urchins and to determine transect width and quadrat size. Survey sites off Southeast Farallon Island were largely selected in habitats where red abalone were abundant according to information from ex commercial abalone divers. Additional sites were selected in rocky habitat. Seventeen dives produced 18 hours of video tape usable for counts and measurements of abalone and sea urchins. A total of 1,660 quadrats (total area = 1439 m2) were generated from the 17usable dives at a fixed time interval along transects. A total of 320 red abalone were observed in transect videos, the highest densities of 0.2 per m^2were observed in 3 to 8m depth range. No abalone were seen below 20 m. Abalone ranged in size from 121 to 210 mm with a mode at approximately 165mm. Red sea urchin counts were subsampled from 686 of the quadrats. Sea urchin density ranged from 1.23 urchins/m^2 in depths of 3 to 8 m to 0.14 urchins/m^2 at depths greater than 20 m. Maps were made with red abalone and red sea urchin occurrence plotted on ROV transects and displayed on top of detailed multibeam bathymetry hilshade images (created by the Seafloor Mapping Lab at California State University Monterey Bay).

City and County of San Francisco Long Term Environmental Monitoring Program in the Gulf of the Farallones, Part 2: Sediment and Benthic Infauna Patterns at the Edge of the Sanctuary

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Tidal currents, long shore currents, outflow through the Golden Gate, and storm waves combine to create the sedimentary environment in the study area with the most prominent feature being the barrier sandbars surrounding the mouth of San Francisco Bay. The area encircled by the sandbars contains predominantly coarse and medium sands. The sandbars themselves are made of well-sorted fine and medium sands. Seaward of the sandbars, the sediments are predominantly fine to very fine sands with varying amounts of silt and clay. The highest proportion of silt/clay occurs just seaward of the sandbars (up to 28%), decreasing to less than 10% silt/clay further seaward from the sandbars. Contaminant loads in the sediments are generally low and variable from year to year. There is no difference in sediment contamination at outfall and reference stations and mean particle size at the outfall has not changed since pre-discharge.

Sediment grain size is the most important factor structuring benthic infauna communities in the study area. The area surrounded by the sandbars has a distinct community of mostly small and interstitial organisms. This coarse-grain community was numerically dominated by the polychaetes Hesionura coineaui difficilis and Heteropodarke heteromorpha, nematodes, and the bivalve Tellina nuculoides. The sand bars, as bathymetric highs, are subjected to the most wave disturbance and are numerically dominated by the polychaete Spiophanes bombyx and characterized by a higher proportion of crustaceans than other infauna communities in the study area. The prevalence of crustaceans in shallow, wave-disturbed environments is consistent with a sand-bottom zonation pattern described for Monterey Bay. The third infauna community, occurring in the area of predominantly very-fine sands seaward of the sand bars, is the most diverse community and has been numerically dominated by the polychaete Spiophanes berkeleyorum and the bivalve Tellina modesta.

Both ordination and cluster analyses confirm the appropriateness of the chosen reference sites for comparison to outfall stations. Reference envelope analysis has identified some outfall stations outside tolerance interval bounds for some infauna diversity measures with the most common pattern being increased abundance at outfall stations compared to reference conditions. However, there is not a consistent pattern and a BACIP comparison of infauna abundance at an outfall and a reference station spanning periods before and after the beginning of wastewater discharge has demonstrated no significant difference. In addition, those species responsible for occasional high abundance at the outfall are not known indicators of enrichment or any other impacts typically associated with wastewater discharges. Long-term patterns of benthic infauna abundance reflect oceanographic cycles including El Niño and La Niña events.

Documented Occurrences of Bird Species on Tomales Bay and a Protocol for Future Bird Species Inventories

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As part of an All Taxa Biodiversity Inventory (ATBI) for Tomales Bay, California, we analyzed 13 years of standardized shorebird and waterbird survey data, the results of numerous published and unpublished reports, and verified anecdotal documentation of bird species occurrences in Tomales Bay.

A comprehensive list of bird species, keyed by taxonomic hierarchy, seasonality, special status categories, preferred habitats, relative abundance, and occurrence within sub-areas, indicates 163 species known to occur or have occurred in Tomales Bay below the mean higher high tide level. These include 122 species that occur regularly or occasionally and 41 species that occur only rarely with less than five documented occurrences. Species normally associated with adjacent habitats were included only if their presence was considered to indicate use of suitable habitats in Tomales Bay. Based on species occurrences in other areas along the Pacific Coast, we predicted that the following undetected species are likely to be found on Tomales Bay: Arctic Loon (Gavia arctica), Northern Fulmar (Fulmaris glacialis), Steller's Eider (Polysticta stelleri), Wilson's Phalarope (Phalaropus tricolor), and Sabine's Gull (Xema sabini).

We also recommended specific protocols for shorebird and waterbird surveys. Analysis of randomized species accumulation curves suggested that optimal efficiency for detecting species (but not necessarily species abundances) can be achieved by conducting 20-35 baywide winter waterbird surveys over a period of five years; a minimum of 20 baywide counts of wintering shorebirds over five years; and a minimum of 20 baywide shorebird counts each during the fall and spring migration periods over at least five years.

A complete report is available at http://www.tomalesbaywatershed.org/resources.html. A bibliography of relevant literature on birds of Tomales Bay is included in the report. The Cypress Grove Research Center of Audubon Canyon Ranch, in Marshall, CA, conducts ongoing shorebird and waterbird monitoring programs on Tomales Bay.

The Role of the Native California Oyster (*Ostreola conchaphila*) as a Foundation Species and Factors Limiting Its Current Distribution in Tomales Bay

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The biogenic structure provided by "foundation" species such as corals, mangroves, seagrass, and oysters can ameliorate abiotic and biotic stress that in turn benefits the fitness of other biota in benthic communities. Oyster beds (*Crassostrea virginica*) on the Atlantic coast of the United States facilitate the presence of other benthic and epibenthic species by providing predation refuge, trophic support, or relief from physical stress. Tomales Bay, like most estuaries on the Pacific coast, once contained large populations of the native oyster (*Ostreola conchaphila*), although harvesting pressures and habitat degradation have reduced *O. conchaphila* stocks to patchy distributions. It is unknown whether *O. conchaphila*, which forms a less complex shell mass than *C. virginica*, functions as a foundation species. Thus, we wish to know if the limited abundance of this species may indirectly alter the community dynamics of Tomales Bay.

During the summer of 2003, we conducted a manipulative experiment to test how *O. conchaphila* aggregations affected invertebrate community structure in Tomales Bay. We established a 50 m intertidal transect at Shell Beach State Park; thirty - 225 cm^2 quadrats with similar *O. conchaphila* densities (i.e. at least 75% oyster cover) were created along the transect. Sessile species composition, abundance, and biogenic structure were quantified within each quadrat. In June 2003, we also randomly assigned 10 quadrats to serve as full oyster removal treatments, 10 as partial oyster removal treatments (25% oyster cover), and 10 as controls (no modification of oyster % cover). In September 2003, all quadrats were sampled with a suction sampler and were subsequently harvested to investigate the species composition and abundance of small/mobile invertebrates. Preliminary results comparing oyster density, structure, and species diversity between treatments indicate that *O. conchaphila* provides a significant amount of biogenic structure that facilitates a higher level of local species richness and diversity than similar areas lacking *O. conchaphila.* Results also illustrate that this positive interaction on invetebrate community structure correlates with a threshold of oyster density and structure.

While oyster populations may represent a major force structuring benthic communities, there is currently no baseline of Tomales Bay *O. conchaphila* populations. Thus, we are quantifying the current state of *O. conchaphila* in Tomales Bay and are examining which variables are most limiting the distribution and abundance of this species. Preliminary findings indicate that the variable and patchy distribution of this species may be due to the interaction of introduced predators and natural gradients in water circulation as well as rocky settling substrate patterns in Tomales Bay. Our overall goal is to combine monitoring, manipulative experiments, and mathematical modeling to understand what regulates the current distribution of this important foundation species. These results will directly assist resource managers who are already attempting to restore native oyster populations to improve the overall health of Tomales Bay.

Environmental Impact of a Submarine Cable: Case Study of the ATOC/ Pioneer Seamount Cable

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To better understand the potential impacts of the presence of cables on the seabed, a study of the environmental impacts of the ATOC/Pioneer Seamount cable was conducted. The 95 km long, submarine, coaxial cable extends between Pioneer Seamount and the Pillar Point Air Force Station in Half Moon Bay, California. Approximately two thirds of the cable lies within the Monterey Bay National Marine Sanctuary. The cable is permitted to NOAA- Oceanic and Atmospheric Research for transmitting data from a hydrophone array on Pioneer Seamount to shore. The cable was installed unburied on the seafloor in 1995. A total of 13 sites along the 95 km cable route were surveyed using MBARI ROVs *Ventana* and *Tiburon* equipped with cable-tracking tools during research cruises on February10-14, 2003 and July 28–August 1, 2003. Quantitative comparison between cable and control sites was performed at nine stations. A total of 42 hours of video footage and 138 push cores were collected over 15.1 km of seafloor. Approximately 12.1 km of the cable was observed (13% of the cable route). The condition of the cable, its effect on the seafloor, and its effect on benthic megafauna and infauna were determined.

Video data indicated the nature of interaction between the cable and the seafloor. Rocky nearshore areas, where wave energies are greatest, showed the clearest evidence of impact. Here, evidence of abrasion included frayed and unraveling portions of the cable's armor and vertical grooves in the rock apparently cut by the cable. The greatest incision and armor damage occurred on ledges between spans in irregular rock outcrop areas. Unlike the nearshore rocky region, neither the rocks nor the cable appeared damaged along outcrops on Pioneer Seamount. Multiple loops of slack cable added during a 1997 cable repair operation were found lying flat on the seafloor. Several sharp kinks in the cable were seen at 240 m water depths in an area subjected to intense trawling activity. Two crossings with other cables were also seen. Most of the cable has become buried with time in sediment substrates on the continental shelf whereas much of the cable remains exposed in sediments at deeper depths. The cable is exposed in rocky environments of the nearshore region and on all of Pioneer Seamount.

The main biological features associated with the cable were organisms utilizing the cable as substrate and occasionally as shelter. Considerable care was taken to count megafauna in video transects and macrofauna from the top 5 cm of push cores. Few differences were found between cable and control sites at the 95% confidence level. Cnidaria (especially anemones such as *Metridium farcimen* and *Stomphia sp.*) colonize the cable and were more abundant in cable transects at most soft sediment sites. Where the cable was buried, the presence of linear rows of anemones proved to be reliable indicators of the cable's position. Flatfish and rockfish apparently congregate near the cable. The cable may also have a subtle local hydrodynamic effect that concentrated shell hash and drift kelp near the cable. Coarse extrapolation of the transect data suggest that approximately 500,000 organisms may live on or near the cable.

San Francisco Bay National Estuarine Research Reserve

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The San Francisco Bay National Estuarine Research Reserve, the 26th in the national reserve system, was officially designated on August 27, 2003 by the National Oceanic and Atmospheric Administration (NOAA). The National Estuarine Research Reserve System is a network of protected areas established for long-term research, education and stewardship of the nation's estuaries. [http://www.nerrs.noaa.gov/]

The SF Bay Reserve is a partnership among the National Oceanic and Atmospheric Administration, San Francisco State University's Romberg Tiburon Center, California State Parks, the Solano Land Trust, and the Bay Conservation and Development Commission. The Reserve is comprised of two sites: China Camp State Park in San Rafael, Marin County, and the Rush Ranch Open Space Preserve near Fairfield and Suisun City in Solano County. The headquarters for the San Francisco Bay Reserve is the SFSU – Romberg Tiburon Center on the Tiburon peninsula in Marin County. [http://online.sfsu.edu/~dhr/nerr/]

San Francisco Bay once supported 190,000 acres of highly productive tidal marsh. Now, only 16,000 acres of this historic tidal marsh remain. The 3,710 acres that comprise the San Francisco Bay Reserve include some of the highest quality remaining historical wetland and adjacent habitat in two large bays of the estuary: Suisun Bay and Marsh (Rush Ranch site) and San Pablo Bay (China Camp site). Collectively, the sites represent approximately 7 percent of the historic tidal marsh left in the San Francisco Estuary. The sites serve as a reference against which enhanced, restored, or created wetlands are evaluated. Tidal marsh restoration will be the focal point of programs in the Reserve.

Rush Ranch is a 2,070 acre site located on the northern margin of Suisun Marsh. It consists of approximately 1,050 acres of brackish tidal wetlands (old high-elevation marsh), 940 acres of grassland, seasonal systems, springs and ponds, and an 80 acre managed wetland. The ranch was purchased in 1988 by the Solano Land Trust through funding provided by the California State Coastal Conservancy. The property contains the largest and most intact brackish tidal marsh system in the entire San Francisco estuary and is bordered by wildlife areas. The brackish tidal marsh at this site is exceptionally rich in vegetation and wildlife. [http://www.solanolandtrust.org/]

China Camp, established in 1978, is a 1,640 acre State Park located on the southwest shore of San Pablo Bay about 3 miles northeast of San Rafael in Marin County. China Camp State Park has one of the largest and most intact remnants of the natural mosaic of wetland and upland natural communities of any stretch of shoreline around the San Francisco estuary. The park has excellent tidal wetlands that are already bordered by interpretive trails. Surrounding the marsh are several habitats that together constitute a relatively intact ecological watershed. [http://cal-parks.ca.gov/default.asp?page_id=466]

The San Francisco Bay Reserve presents exciting new opportunities for residents the Bay area. A few highlights of the benefits that the Reserve will bring to the Bay Area include:

- Workshops for environmental professionals on topics such as geographic information systems, restoration science, estuarine ecology, and harmful algal blooms
- Educational programs for students and the public at large

- National System-wide Monitoring Program for water quality and weather
- NOAA Graduate Fellowship Program that supports two graduate fellows each year
- Improved stewardship of the natural resources of San Francisco Bay

Comparison of Biodiversity Patterns Among Rocky Intertidal Communities

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Biodiversity patterns of rocky intertidal communities were compared among twenty-one sites on the Channel Islands excluding San Clemente Island, and forty-four mainland sites between Cape Mendocino, California and Pta. Baja, Baja California Norte using spatially explicit grid surveys. Grid surveys standardized the level of effort, area and taxonomic expertise used in sampling to give an unbiased estimate of community composition and diversity.

The grid surveys combine various biological sampling techniques. A thirty-meter baseline was setup within the splash zone of the intertidal parallel to the ocean. Eleven transect lines were laid out from this upper baseline and extended to the edge of the ocean at low tide. These lines were spaced 3 m apart and crossed perpendicularly all zones of the intertidal. For some sites the survey was divided into two sections. This occurred when thirty meter of contiguous rocky substrate did not exist.

One hundred points were sampled along each transect line using a uniform point contact method. The sampling interval was determined by the length and rugosity of the bench. By standardizing the number of points sampled per line comparisons can be made between benches of different lengths. Three species were recorded for each point. The species directly under the point was considered the initial point. The initial point may also be rock, sand or tar. The next two closet species were then recorded. If there happened to be two or more species directly under the initial point all were recorded as the initial point. This occurred with layers of different species of algae or with epibionts/epiphytes living on a host. Substrates such as cobble, boulder, or pool were also recorded for each species found under the point. This gives us a total of 3300 points per site. The initial point was used to determine percent cover at a site. While the next two species recorded for a point are used to determine species associations and to survey species that are less common in the intertidal.

Mobile invertebrates are often under represented by point contacts method of sampling. Three half meter squared quadrats were placed within the high, mid and low zone along each line in order to sample mobile invertebrates. All of the mobile invertebrates found within these quadrats were counted.

Sea stars, an important predator, and abalone, a rare species, were courted along a two meter swaths centered along each transect line.

Measurements of rock height in relation to sea level were recorded along each of the transect lines. These measurements were then used to make a detailed topographic map of the intertidal site.

The spatially explicit grid surveys are characterizing the structure of rocky reef intertidal communities over an unprecedented geographical scale. The results of our analyses show clearly defined geographic breaks in biodiversity patterns that appear to be consistent with oceanographic and geomorphological forcing. By creating fine scale topographic and biological maps of the intertidal we are gaining incite on how physical complexity affects biological communities.

Inter- and Intra-Annual Patterns of Phytoplankton Assemblages During Upwelling Events off the Coast of Northern California

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The phytoplankton community composition and its relationship to upwelling conditions are described for three upwelling seasons (the summers of 2000, 2001 and 2002) and one non-upwelling season (winter of 2002) for the coastal ecosystem off Bodega Bay, California, just north of the Gulf of the Farallones National Marine Sanctuary. Phytoplankton in this region responded typically to the upwelled nutrients, with increased numbers reaching bloom concentrations closest to shore on the continental shelf. 2000 was the year with the highest chlorophyll concentrations and cell numbers, and the lowest wind forcing. The community for all three upwelling seasons, as identified by the Utermohl technique, was dominated by a centric diatom, Chaetoceros socialis, and other members of the same genus, forming a Chaetoceros complex. Diatoms common to upwelling regions, such as Rhizosolenia spp. and Thalassiosira spp. were also identified as members of this functional group. Flagellates were dominant when chlorophyll concentrations were low at the end of upwelling events, farther offshore, or in the winter non-upwelling season.

Locating Marine Reserves Based on Coastal Features: Coupling Ocean Circulation and Larval Settlement Around a Headland

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I am investigating small-scale spatial and temporal patterns of invertebrate larvae in the nearshore environment by coupling physical oceanographic data with larval settlement patterns. This study will help elucidate the relationship between ocean circulation, coastal topography, and nearshore community dynamics on a scale that is relevant to the size of proposed marine reserves (no-take zones) in the region. This project will also contribute valuable ecological knowledge about the mechanisms that accumulate and deliver larvae to the nearshore environments, which contribute to structuring nearshore marine communities. I am examining how small-scale topographic features such as headlands (4-10km) affect the delivery of twenty taxa of marine invertebrate larvae to nearshore habitats. This comparative approach will enable me to investigate whether diverse species recruit via different mechanisms along the shore.

During the peak settlement season of March through August 2000-2003, I monitored settlement of marine invertebrate larvae using three replicate moorings with artificial substrate settlement collectors at various locations. Each mooring had collectors at two depths (surface and bottom) and consisted of a mesh bag containing 3 Tuffy scrub pads, and a barnacle plate and a temperature logger. I sampled these collectors every 2-15d and I collected continuous salinity and wind stress data and weekly site-based CTD data.

In 2000, I monitored a long-term site (9 yr) adjacent to the Bodega Marine Laboratory. In 2001, I expanded the monitoring to include 7 sites around Bodega Head to identify spatial patterns of settlement around a headland. I have found a strong pattern of larval settlement where larvae consistently settled in higher densities in the lee of the headland than along the windward side, indicating the presence of an accumulation zone. My preliminary results also indicated that species richness and abundance of settlers differed between the surface and the bottom suggesting that larvae are transported in wind-driven surface water and upwelled bottom water. In 2002, I increased the sampling frequency at 4 sites to investigate temporal patterns of settlement and mechanisms of larval transport. I am analyzing physical data and settlement data to determine if settlement is correlated with upwelling/relaxation events and internal waves. In 2002, I also examined the average length of time settlers remain on the collectors to determine when the collector ceases to accurately sample the relative supply of competent settlers. Preliminary results indicate that the average length of time varies among taxa and ranges from 4-8 days.

Investigating small-scale nearshore processes is necessary to identify features along the California coast that facilitate the accumulation of planktonic organisms, which seed nearshore benthic populations. Determining if these features are predictable spatially and temporally is key to understanding the population and community dynamics of nearshore benthic organisms. If circulation patterns can be predicted based on coastal features at multiple scales, then coastline structure and ocean circulation should be considered when designing marine reserves.

Restoring Common Murre Colonies in Central California: An Update

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In 1996, a social attraction project was initiated on Devil's Slide Rock in central California to restore a recently extirpated colony of Common Murres (*Uria aalge*). Twelve plots of murre decoys, including adults, eggs, and chicks, along with a sound system broadcasting murre calls, were placed on the rock at varying densities to attract potential breeders and assess responses to plot treatments. Small numbers of murres quickly recolonized the rock and six pairs produced three chicks in 1996. Social attraction efforts have continued at Devil's Slide each year since 1996. The project exceeded it's 10-year goal of 100 breeding pairs in 2001 (year 6) when 113 pairs nested, and the colony remained over 100 pairs in 2002-2003. In 2000, we began reducing the numbers of decoys, and in 2002 the plot treatments were abandoned to adaptively manage for increased numbers and densities of murres in established nesting areas, in anticipation of complete decoy removal by 2008. In 1998-2003, similar social attraction methods were applied at nearby San Pedro Rock, where a murre colony was extirpated in the early 20th century. While small numbers of murres visited the decoy areas each year, no breeding has occurred. Through adaptive management, including the addition of Brandt's Cormorant decoys and predator management, we hope to eventually reestablish this nesting colony. A lack of recolonization at San Pedro Rock to date may reflect no recent murre breeding, absence of nesting Brandt's Cormorants, activities of avian predators, and focused attendance/recruitment at nearby Devil's Slide Rock.

Population Trends of Brandt's Cormorants in the Gulf of the Farallones, California, 1985-2002

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In 1996 a collaborative restoration project was initiated to reestablish Common Murre (*Uria aalge*) colonies along the central California coast. The resulting colony monitoring and aerial photographic survey data have shown an association between colony formation in Common Murres and nesting Brandt's Cormorants (*Phalacrocorax penicillatus*). Though population trends for murres in central California are well known, region-wide cormorant survey data had not been analyzed. Understanding the effects of environmental changes on murre population trends is often exacerbated by large-scale mortality from gill-net fishing and oil spills. To help elucidate factors affecting the recovery of murres in central California, we examined breeding population trends of Brandt's Cormorants in the Gulf of the Farallones from region-wide aerial photographic surveys conducted in 1985-2002, with additional reference to earlier surveys. Cormorants, especially Brandt's, share similar resources with murres but suffer less from anthropogenic mortality. Brandt's are the most abundant cormorant in the region and nest at the North and South Farallon Islands and several nearshore colonies. They show some interannual movement between subcolonies and colonies that may reflect local breeding conditions, and numbers of nests were greatly reduced during major El Niño events. Preliminary analyses indicate increasing numbers of Brandt's Cormorants along the mainland coast, mostly because of rapid increases at three newly-established in the mid-1990s. Numbers at the largest colony in the region at the South Farallon Islands have been variable, with no obvious trend although this colony may be experiencing a recent increase.

Upper Water Column Monitoring at the San Francisco Deep Ocean Disposal Site (SF-DODS) 1996-2001: Six Years of Data on Hydrography, Chlorophyll, Nutrients, Euphausiids, and Fish Larvae West of the Gulf of the Farallones National Marine Sanctuary

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The Long-Term Management Strategy (LTMS) for the placement of dredged material addresses concerns about potential adverse environmental impacts at dredging sites and at in-bay disposal sites. The LTMS was developed by affected and concerned public agencies and private parties with the U. S. Environmental Protection Agency and the California State Water Resources Control Board as the respective lead federal and state agencies. Disposal of dredged material at sea is a component of the LTMS.

In 1994 the EPA designated the San Francisco Deep Ocean Disposal Site (SF-DODS) at a location approximately 49 nautical miles west of the Golden Gate Bridge. This site was expected to experience localized, temporary impacts as a result of dredged material disposal within the site boundaries. However, no long-term impacts on the Gulf of the Farallones region were expected. Monitoring of upper water column organisms was required and occurred in 1996, 1997, 1998, 1999, 2000, and 2001.

In 1996 and 1997 monitoring was done by personnel of the National Marine Fisheries Service Tiburon Laboratory (Roberts et al. 1997, Roberts et al. 1998). In 1998, 1999, 2000, and 2001 the monitoring was performed by San Francisco State University (McGowan et al. 2000, McGowan et al. 2003). The studies characterized the distribution, abundance, and physiological condition of selected taxa that are representative of the upper water column (0-200 m) macrozooplankton and micronekton assemblage: euphausiids (krill) that are important food items for fish, birds, and marine mammals, and also larval and juvenile fishes that constitute the potential next generation of adult fishes.

The context for the biological data included vertical CTD/Niskin bottle profiles (0-500 m) of salinity, temperature, chlorophyll, nitrates, and silicates in the study area.

To account for seasonal variation at the SF-DODS and in the Gulf of the Farallones, the field program collected samples during each of the three oceanographic seasons each year. The winter season (mid-January to mid-March) is generally a period of storm activity and is the time of spawning for most of the target fish species, including Pacific hake and shortbelly rockfish. The upwelling season (mid-May to mid-June) is characterized by strong northwesterly winds, which cause surface water to move offshore, to be replaced by cold nutrient-rich water from below. The oceanic season (mid-August to mid-October) is characteristically a time of good weather and light winds. Ocean water is generally warmer and low in nutrients at this time.

Satellite images of sea surface temperature during the time periods of the monitoring cruises present a synoptic picture of large scale conditions and graphically show the differences in oceanic properties between seasons and between years.

No meaningful negative impacts of dredged material disposal were detected during upper water column monitoring 1996-2001.

Identifying Priority Conservation Areas for the Baja California to Bering Sea Region

Lance Morgan

Marine Conservation Biology Institute

Interest in networks of marine protected areas (MPAs) for conserving marine biodiversity and strengthening fishery management has increased dramatically in the last few years because the dominant paradigm–command-and-control regulation–has failed to stop biodiversity loss and fisheries collapse. In the sea, as on land, successful place-based strategies require identifying conservation targets, so the first step of a rational MPA strategy is producing a map of the highest priority places to protect. Priority in this case reflects not only the conservation, but also the threats and opportunities to protecting these sites.

Working in cooperation with the North American Commission for Environmental Cooperation, and the Baja California to the Bering Sea Marine Conservation Initiative (B2B), MCBI has produced a map of priority conservation areas from Baja California to the Bering Sea. Here I describe our approach to delineating priority areas in the Northeast Pacific Ocean based on development of a broad scale geographic information system. The development of this GIS provides a framework for incorporating many diverse databases, and aids in identifying poorly known areas based on their similarities in bathymetry and remotely sensed satellite data to areas with better known species diversity and abundance. In total 28 areas have been identified as priority conservation areas. These areas will be focal points for further action to develop a continental network of MPAs.

Occurrences of Selected Habitat Forming Deep-Sea Corals

Lance Morgan

Marine Conservation Biology Institute

Habitat forming deep-sea corals in the Northeast Pacific are potentially important seafloor habitats for a variety of species including commercially important rockfishes (Sebastes spp.) A total of 2661 records are presented (with geoposition) from 10 institutions on 8 habitat forming deep-sea coral families, octocorals: families - Corallidae, Isididae, Paragorgiidae and Primnoidae; hexacorals: families Antipathidae, Oculinidae and Caryophylliidae; and hydrocorals: family - Stylasteriidae. We ranked records according to data quality based upon collection and identification methods and expertise. The Family Isididae has the deepest record at 3880 m, and the Families Antipathidae, Primnoidae, Corallidae, and Paragorgiidae all have records deeper than 1900 m. Records within the Gulf of the Farallones region include members of the families Isididae, Primnoidae, Paragorgiidae and Stylasteriidae. It is likely that the others are also present but have not yet been recorded, based on records from other locations in central California.

City and County of San Francisco Long Term Environmental Monitoring Program in the Gulf of the Farallones, Part 1: History and Overview

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The City and County of San Francisco (CCSF) conducts monitoring within the near-shore Gulf of the Farallones to evaluate effects from the discharge of treated wastewater into the Pacific Ocean. Although technically not a part of the Gulf of the Farallones National Marine Sanctuary, this long term monitoring data provides information that can be useful in the management of the Sanctuary Program. CCSF operates a combined sewer system in which all flow during dry weather and almost all flow during wet weather is treated and discharged approximately 4 miles offshore of Ocean Beach.

Environmental monitoring from sites in the discharge area compared to reference conditions includes the assessment of physical and chemical characteristics in marine sediment; community assessments of benthic infauna, demersal fish and epibenthic invertebrates; and tissue contaminant burdens in English sole and Dungeness crab. Sediment characteristics and benthic infauna community measurements provide the best data sets to identify long-term changes in the environment (separate presentation). Demersal fish and epibenthic invertebrate community data and contaminant bioaccumulation data are more difficult to assess due to the mobility of the organisms.

Traditional monitoring designs utilizing a single reference location to which potential impact sites are compared did not allow a satisfactory assessment of environmental conditions. In order to better characterize the near-shore Gulf of the Farallones and to account for effects from outflow through the Golden Gate, the study area extends approximately from Rocky Point in Marin County to Point San Pedro in San Mateo County. Stations range from approximately 1 to 13 kilometers offshore in depths from about 11 to 36 meters.

The program also includes a component for the protection of public health in beach monitoring for bacteria contaminants along the San Francisco shoreline. Three bacteria indicator organisms are monitored at least once per week along each beach year round. Beaches are posted when bacteria concentrations exceed State of California water contact recreation standards. Rainfall has the largest impact on increases to bacteria concentrations. Beach water quality information is available on a toll free hotline (1-877-SF BEACH) and at the San Francisco Public Utilities Commission website (http://beaches.sfwater.org).

EMAP/NOAA 2003 Survey of Ecological Conditions of the Western U.S. Continental Shelf, Including Gulf of Farallones National Marine Sanctuary

Walt Nelson

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In June of 2003 a partnership between EPA, NOAA, and the western coastal states conducted a joint survey of ecological condition of aquatic resources along the U.S. western continental shelf (30-120 m), using multiple indicators of ecological condition. The study is an element of EPA's Environmental Monitoring and Assessment Program (EMAP). An element of study design included the assessment of condition in the five NOAA west coast National Marine Sanctuaries (NMS) as compared to non-sanctuary areas of the shelf. A total of 146 stations were successfully sampled from the NOAA Ship *McArthur* II, including 30 stations in the Olympic NMS, 12 stations in the Gulf of Farallones NMS, 1 station in the Cordell Banks NMS, and 14 stations in the Monterey Bay NMS. Channel Islands NMS was sampled as part of the Bight 03 survey, and these data will be integrated with the EMAP/NOAA survey results.

The environmental condition indicators sampled from *McArthur* II included measures of: (1) general habitat condition (depth, salinity, temperature, pH, total suspended solids, light transmittance, sediment characteristics); (2) water quality indicators (chlorophyll *a*, nutrients, dissolved oxygen concentration); (3) pollutant exposure indicators (sediment contaminants (metals, pesticides, PCBs, PAHs), fish tissue contaminants (metals, pesticides, PCBs)); and (4) benthic condition indicators (diversity and abundance of benthic infaunal species, fish pathological anomalies). Additional fish tissue contaminant samples were obtained from the NMFS 2003 Shelf Slope Survey. Sediment and tissue contaminant samples are currently undergoing laboratory analysis. Preliminary data from the cruise should be available in the fall of 2004. This study represents the first benthic condition assessment spanning the continental shelf of Washington, Oregon and California. It also represents the first comparison of benthic condition between the National Marine Sanctuaries and the continental shelf outside NMS jurisdiction at regional scale.

The SIMoN Website as a Resource for Marine Educators

Josh Pederson, Chad King, and Sarah Smith

Monterey Bay National Marine Sanctuary

SIMoN, the Sanctuary Integrated Monitoring Network, is a state-of-the-art web site that provides users fast, easy access to the latest high quality, scientific research and monitoring information on the Monterey Bay National Marine Sanctuary's major habitats, species and issues. Through the SIMoN web site, marine educators can access a variety of information relevant to developing and enhancing marine science curriculum. The SIMoN website summarizes major habitats in the Sanctuary through textual information, maps and graphs, and monitoring trends. SIMoN supplements this overview information by providing links to general and educational websites.

Users can also find information about current and historic monitoring projects conducted in the Sanctuary, as well as use the SIMoN interactive mapping application to create maps using MBNMS GIS data layers. The SIMoN website is not only useful for scientists and resource managers, but serves as a powerful tool for educators.

SIMoN is a collaborative effort, managed by the Monterey Bay National Marine Sanctuary in cooperation with the Monterey Bay Sanctuary Foundation and the Monterey Bay Aquarium.

The SIMoN Website as a Tool for Sharing Monitoring Information

Josh Pederson

Monterey Bay National Marine Sanctuary

SIMoN, the Sanctuary Integrated Monitoring Network, is a comprehensive, long-term program designed to promote better understanding and protection of the Monterey Bay National Marine Sanctuary and its resources. By gathering data on the historical and on-going monitoring efforts of over 40 research institutions operating within the MBNMS, SIMoN is able to provide important information to researchers, managers and the public.

The internet is the primary medium SIMoN uses to disseminate this monitoring information. For each of the major habitats and issues in the Monterey Bay National Marine Sanctuary the SIMoN website shares overview information, maps and graphs, details on current and historic monitoring projects, educational materials, and links to other relevant websites. Coupled with a mapping application that allows users to create maps using MBNMS GIS data layers, the SIMoN website is an innovative new approach to sharing monitoring-based information with a wide audience.

SIMoN was designed to serve as a model for other National Marine Sanctuaries, and will be implemented at NMS sites in coming years. The program is a collaborative effort, managed by the Monterey Bay National Marine Sanctuary in cooperation with the Monterey Bay Sanctuary Foundation and the Monterey Bay Aquarium.

Ecological Impacts of Green Macroalgal Mats in Drakes Estero

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This study investigated the ecological impacts of green macroalgal mats comprised of *Enteromorpha sp.* on the tidal flats of Drakes Estero, a coastal estuary located in the Point Reyes National Seashore, during June-October 2003. Blooms of green macroalgae occur naturally in coastal embayments, estuaries, and lagoons worldwide. Anthropogenic nutrification and alteration of local hydrographic processes, however, may create eutrophic conditions that favor mass blooms of vast macroalgal mats. Green macroalgal mats may have profound effects on sediment chemistries, water column dynamics, invertebrate communities, and upper trophic levels, including shorebirds and waterfowl. By means of an algal transplant experiment, I studied the effects of *Enteromorpha* mats on sediment redox potential, sediment particle size, sediment percent organics, `fxinvertebrate community composition, and shorebird foraging behavior. Six experimental blocks were established, each comprised of four randomized treatments: 1) macroalgal mat added, shorebirds excluded, 2) macroalgal mat added, open to shorebirds, 3) no algae, shorebirds excluded, 4) no algae, open to shorebirds (control). The blocks were spaced 4 meters apart near the edge of the tidal flat and parallel to the water line. Within each block, the 4 treatment plots were arranged with 2 plots on the southern side of the block and 2 plots on the northern side, each measuring 1 by 2 meters and spaced 1 meter apart. For the shorebird exclosures, I constructed _ inch diameter PVC pipe frames that bordered the edge of the treatment plots and stood approximately 15 cm high, thus blocking shorebirds from entering the plots. *Enteromorpha* was transplanted by collecting it from nearby macroalgal mats, rinsing the algae of sediment and organisms, and laying it out over the plots in a thick, even layer. The algae was held in place with plastic mesh netting and plastic stakes. Sediment measurements and invertebrate cores were taken prior to establishment of the treatments and at the end of the experiment to facilitate analysis of the data through ANCOVA. During both sampling rounds, three replicate invertebrate core samples were taken from randomly selected points within each plot. Cores were taken to a depth of 15 cm using a 10 cm diameter corer. Sediment samples were collected similarly but using a 1 inch diameter PVC pipe instead. During September-October, I conducted behavioral observations of Marbled Godwit (*Limosa fedoa*), Black-bellied Plover (*Pluvialis squatarola*), and Western Sandpiper (*Calidris mauri*) – three shorebird species representing different foraging strategies based on anatomy and behavior. I used a spotting scope for all the shorebird observations from the top of a bluff adjacent to the study site. Shorebirds were randomly selected for 5 minute fixed observation intervals, during which time foraging rate and time spent on macroalgal mats versus the open mudflat were recorded. The processing and analysis of core samples and bird data collected from Drakes Estero is ongoing, and I am thus unable to report any results from this study at this time.

Syndrome in Wild Abalone Within the Gulf of the Farallones National Marine Sanctuary

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The California Department of Fish and Game Shellfish Health Laboratory is continuing to investigate the geographic spread of the causative agent of withering syndrome (WS) in wild abalone *Haliotis spp.*. WS is a lethal bacterial disease of wild and cultured abalone. The etiological agent has been recently identified as a rickettsia like prokaryote (RLP) infecting digestive epithelia of abalone. The WS-RLP has historically decimated central and southern California abalone populations resulting in a fishery closure of all species there in 1997. The WS-RLP has been geographically observed spreading northward as far as Point San Pedro, south of San Francisco. Current methods to survey field sites include determining prime abalone habitat locations, abalone/tissue collections, and laboratory post-collection processing for histology and molecular detection of the WS-RLP. Several sites within and adjacent to the Gulf of Farallones National Marine Sanctuary (GFNMS) have been surveyed in 2003, but further effort is required to firmly establish the presence or absence of this infectious disease within the sanctuary. The Point Reyes Headlands have been surveyed and found to be rlp-free. The Marin Headlands near Muir Beach, Slide Ranch near Stinson Beach and Rocky Point/Steep Ravine Environmental Campground in the Golden Gate National Recreation Area proved to be unsuitable habitat with no abalone located or collected, perhaps indicating a geographic barrier to the potential for more northerly spread of the bacterium. The Farallone Islands, which supported a commercial red abalone fishery prior to the statewide closure, are of prime interest for future examination. The original detection of the RLP at the Channel Islands has historically demonstrated that its spread is not exclusively coastal and that abalone found on other islands, may be subject to infection as well. Fortunately, both laboratory and field studies indicate that cool water can provide a thermal refuge from RLP pathogenicity and WS expression so that if the pathogen becomes established in the GFNMS, the disease may not be as severe as that seen in the central and southern California. Supported in part by the Marine Region, California Department of Fish and Game.

Beached Bird Surveys and Chronic Oil Pollution in Central California

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This report summarizes beached bird and oil pollution data gathered from September 1993 through August 2002 by Beach Watch, a long-term shoreline monitoring program. Surveys were conducted at 32 beach segments ranging from southern San Mateo County to southern Sonoma County. Beached birds were most commonly found in August and September, and most birds at this time were local nesting marine species. During the 97/98 El Niño-Southern Oscillation (ENSO) event, the annual encounter rate for all beached birds more than doubled, and the encounter rate for oiled birds increased more than six-fold. Also during the 97/98 ENSO the encounter rate for tarballs (hardened patties of oil) was more than twenty times that observed for the preceding year. Periodic increases of oiled birds and tarballs may have reflected the corresponding releases of heavy fuel oil from long submerged vessels, such as the S/S Jacob Luckenbach, as well as illegal discharges from merchant and tank vessels. Overall the percentage of beached birds found oiled was lower than that reported in the southern North Sea (1977-1997) and in Newfoundland (1984-1999). Comparison with an earlier beached bird dataset from central California from 1971 to 1981 (Stenzel et al. 1988) suggests that oiling rates have declined since that decade. The observations recorded by Beach Watch have contributed to the discovery, identification and prosecution of sources of pollution.

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Remotely Operated Vehicle Survey of Channel Islands Marine Protected Area

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Federal, state, NGO and commercial personnel and equipment were coordinated by Marine Applied Research and Exploration (MARE) to perform a baseline biological and habitat survey in the Channel Islands Marine Protected Area. The team conducted 11 dives, totaling nearly 50 hours of video at 8 sites inside and outside reserves of similar depth and habitat over 6 days offshore. 16 km of bottom habitat were flown in November 2003 with a Phantom Remotely Operated Vehicle (ROV) from aboard the National Oceanographic and Atmospheric Administration (NOAA) R/V Shearwater. This archival data is currently being analyzed for habitat characterization and marine life for future comparison monitoring at the same locations. Five more operational days are scheduled in May 2004.

The project is a Baseline ROV biological and habitat survey and exploration of prioritized areas as defined in the draft Channel Islands Monitoring Plan. California Department of Fish and Game (CDFG) has identified eight (8) priority areas to be surveyed, inventoried and monitored. United States Geological Survey and California State Monterey Bay Seafloor Mapping Lab recently completed and made available high-resolution acoustic maps of these areas that greatly increased project efficiency. This allowed focus on rocky reef habitat, and exclusion most of the sand habitat. The surveys were performed at depths between 25 and 70 meters in November 2003. The ROV video was digitally recorded along with exact GPS location, depth, water temperature, date and time. Habitat is being characterized and reported along with generation of prime species maps as part of the post-processing endeavor. The final product will include GPS-referenced species and habitat data, ROV video footage, and ROV data gathering methods and protocols.

Sites approximately 500m x 2km were overlaid on multi-beam or sidescan images of reef habitat at each of three reserve sites and on parallel adjacent reefs 200m outside of reserve boundaries. Each site consists of a zig-zag pattern of four legs 500 m in length ascending at an angle to the depth contour from deep to shallow. Transect legs are plotted with a ±10 m buffer to confine pilotage along a straight line by both the vessel and the ROV. The depth range of a given site depends on the degree of slope and normally runs from 70 to 30 m. Reserve sites were paired with adjacent non-reserve sites at comparable depth and reef habitat spaced approximately 200 m from the reserve boundary.

Results compared with future monitoring could demonstrate any changes to habitat or between fished and non-fished zones, and guide adaptive management of sites.

We appreciate the personnel and equipment support from the following groups: CDFG- personnel and ROV, NOAA- ship and operations crew, Deep Ocean Engineering-ROV operations personnel and support, The Nature Conservancy-keystone funding and project publicity, Cordell Bank National Marine Sanctuary and Oregon Fish and Wildlife-backup equipment and local support was provided by U.C. Santa Barbara and Santa Barbara City College.

Seabirds in an Estuarine Environment: The Story on Alcatraz Island, California

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In recent years, Alcatraz Island, in the San Francisco Bay estuary, has become an important breeding site for seabirds, including Brandt's Cormorant (*Phalacrocorax penicillatus*), Pelagic Cormorant (*P. pelagicus*), Pigeon Guillemot (*Cepphus columba*), and Western Gull (*Larus occidentalis*). Alcatraz is of interest as a seabird breeding colony due to its estuarine environment, location near a major urban center, and status as a tourist attraction with over one million annual visitors. We synthesized available breeding population data for these four species during 1990-2003. Brandt's Cormorants established a colony on Alcatraz that expanded to over 460 breeding pairs during the study period. From a possible clutch of 5 eggs, Brandt's Cormorant annual average productivity varied between 1.6 and 2.6 chicks per pair during 1997-2003. Pelagic Cormorant and Pigeon Guillemot populations varied between 14 to 20, and 17 to 23 breeding pairs, respectively, during 1997-2003. There was no significant trend in Pelagic Cormorant or Pigeon Guillemot population size. Pelagic Cormorant annual average productivity varied between 1.9 and 3.0 chicks per pair during 1999-2003. From 1990-2003, the Western Gull breeding population averaged 6% annual growth, and varied from 357 to 825 breeding pairs. Western Gulls can lay 3 eggs, and exhibited an annual average productivity between 1.0 and 1.9 chicks per pair during 1999-2003. Currently increasing or stable seabird populations on Alcatraz are exposed to numerous anthropogenic threats, including human disturbance, oil spills, contaminants, and tourism pressures. Despite these potential disadvantages, productivity of Brandt's Cormorants, Pelagic Cormorants, and Western Gulls on Alcatraz is almost consistently higher than local offshore colonies on Año Nuevo Island and Southeast Farallon Island. Mechanisms for the success of breeding seabirds on Alcatraz likely include high and consistent prey availability in San Francisco Bay. Further monitoring of Alcatraz seabirds is warranted to investigate human impacts on seabird populations in San Francisco Bay, and to explore the ecology of typically pelagic seabirds in an estuarine environment.

Feeding and Behavioral Ecology of Whale Watchers with in the Gulf of the Farallones National Marine Sanctuary

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Abstract: Whale watchers are present throughout the year in the waters of Gulf of the Farallones National Marine Sanctuary (GFNMS) off San Francisco. However, seasonal distributional shifts regularly occur from nearshore waters (winter/spring) to offshore waters in summer and fall, at which times sighting of whale watchers increase in the Gulf. Whale watchers can be found ranging from nearshore waters to the Farallon Islands at the Continental Shelf break, approximately 5nm beyond Southeast Farallones. This study expands upon a previously reported documentation of the feeding ecology of whale watchers over the period 1992-1996, and includes additional behavioral observations. These behaviors are linked to whale watcher energetics observed during subsequent research seasons.

Foraging strategies and patterns: Data were compiled for a total of 380 whale watch excursions; average sampling size per survey/cruise was 43 (CV +/- 10). Whale watcher behaviors included targeted feeding; opportunistic, incidental and accidental ingestion of prey items. Foraging strategies included: 1) advance provisioning, as evidenced by prey packaged in household or off-site source containers; 2) spontaneous/on-site provisioning (food in local delicatessin packaging). 3) Opportunistic and incidental feeding behaviors were also observed, i.e., kleptoparasitism of co-passengers' food, or food obtained through begging behaviors. Accidental feeding occurred primarily when whale watchers ingested kelp flies along with their target prey or during passenger vocalization. Although feeding bouts occurred throughout the day, they increased significantly in frequency and intensity in direct relation to the vessel's proximity to Fisherman's Bay on Southeast Farallon Island. As this generally occurred around midday, time of day could be a contributing factor to this increased feeding effort.

In cases of deliberate ingestion, selection of the above strategies appeared to be idiosyncratic among individuals, with no significant demographic trend noted. That is, no specific age or gender group was identified with specific behaviors. However, a curious recurrent behavior which may be specific to this whale watcher population is the ritualistic consumption, primarily by naturalists and captains, of M&M candies. This is superstitiously believed to increase success in whale sightings. This behavior has recently begun to spread to more experienced whale watchers as well (Capt. M. Menigoz, pers. comm.). However, there are still no data available to support the sighting success-M&M theory.

Other Energetics-related Behaviors: Air temperatures in the Gulf are low year-round, and these conditions are intensified when the vessel is underway. Methods of retaining body heat include mechanisms such as thigmotactic behavior/crèche formation (huddling), and thermoregulation through spontaneous layering or molting of insulating garments. Accidental loss of energy, heat and body fluids sometimes occurred through regurgitation, a behavior strongly correlated to sea state and inexperience at sea.

Environmental and Geographic Influences: Although weather does not seem to affect deliberate feeding behaviors, both weather (i.e., warm, windless days) and proximity to SE Farallon Island were conducive to most incidents of kelp fly ingestion.

Journal of Whale Watcher Ecology, in press

Sustainable Seas Student Intertidal Monitoring Project at Duxbury Reef in Bolinas, CA

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The Sustainable Seas Student Monitoring Project at the Branson School in Ross, CA has monitored Duxbury Reef in Bolinas, CA since 1999. In cooperation with the Farallones Marine Sanctuary Association, goals include: 1) To monitor the rocky intertidal habitat and develop a baseline database of density and abundance; 2) To contribute to the conservation of the rocky intertidal habitat through education of students and visitors about intertidal species and requirements for maintaining a healthy, diverse intertidal ecosystem; and 3) To increase stewardship in the Gulf of the Farallones National Marine Sanctuary. Student volunteers complete an intensive 22 hour training course on the natural history of intertidal invertebrates and algae, identification of key species, rocky intertidal ecology, interpretation and monitoring techniques, and history of the sanctuary. Students conduct four baseline monitoring surveys three times per year (fall, winter, and late spring) to identify and count key invertebrate and algae species. During 2000-2002, the density of black turban snails, Tegula funebralis, was lowest in the high intertidal zone in winter yet had little seasonal variability in the mid intertidal zone. Most algae species had consistently higher percent cover in the northern transects than the more accessible southern transects. To test the reliability of the student counts, replicate counts of all species were performed. Replicate counts for invertebrate species within the same quadrat along the permanent transects revealed a very small amount of variability, giving us confidence that our monitoring can provide reliable data. Student volunteers helped to design and install a rocky intertidal information kiosk to greet visitors at the entrance of Duxbury Reef. The kiosk includes pictures and natural history information on key intertidal species as well as tidepooling etiquette. Students lead an annual celebration at Duxbury Reef through intertidal walks for the public.

The California Center for Ocean Science Education Excellence (COSEE): Engaging Ocean Science Researchers in K-14 Education

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Answering the call to create environments in which collaborations among ocean scientists and K-12 education experts flourish, the NSF funded California Center for Ocean Science Education Excellence (COSEE) marshals the considerable resources and conviction of Scripps Institution of Oceanography, University of California, San Diego; the Marine Activities, Resources and Education Program at the Lawrence Hall of Science, University of California, Berkeley; the Marine Advanced Technology Education Center at Monterey Peninsula College; and California Sea Grant. With the shared goal of enhancing the general public's understanding and appreciation of the ocean, these organizations have launched a strategically crafted campaign to integrate ocean education and research. *California COSEE* is focused on the following objectives: 1) deepening the involvement of ocean scientists in K-14 education and outreach efforts; 2) expanding the access of under-served students to ocean science and to science and technical careers; and 3) increasing the degree to which ocean science is included in the K-14 science curriculum.

California COSEE offers the vision and strategically linked resources to play a catalytic role in the development of the national COSEE program. *California COSEE* has embarked on a carefully balanced mix of activities that includes networking and infrastructure building along with strategic, model programs that have immediate impact and potential for broad national dissemination. Through a multifaceted approach, this partnership will create unprecedented opportunities for collaborations between highly regarded scientists and science educators. The establishment of *California COSEE* represents a fundamental shift within one of the nation's premiere research institutions and portends institutional change in the perception of the value and efficacy of ocean science outreach and education. Moreover, through sustained effort to conduct outreach among populations historically underrepresented as learners, teachers, researchers and technicians in ocean science, *California COSEE* promises to extend opportunities and experience in the field of ocean science and technology to the diverse population of California and the nation.

On the Limits of Existence: Status of Marbled Murrelets in Sonoma, and Marin Counties

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Marbled Murrelets are small seabirds with the unique adaptation of nesting on high branches of larger trees in mature forests, rather than offshore islands. This adaptation rendered the species vulnerable to extensive habitat loss when older forest stands were harvested for lumber, beginning in the 1800's. Evidence of a small and declining population prompted Federally Threatened Species designation and California Endangered species status in 1992 (USFWS 1997). Adaptation to avoid predation in the forest environment (cryptic coloration, solitary nesting, low site fidelity, and crepuscular activity periods) has made research into the biology of the species extremely challenging and expensive in their nesting areas. At sea in California, Marbled Murrelets are distributed very close to shore, rarely occurring over 8 km offshore, and concentrated within 1.2 km of shore (Ainley et al. 1995, Becker et al. 1997, Ralph and Miller 1995, Strong et al. 1997). The region from Pt. Arena to San Francisco remains the least known area on the U.S. coast in terms of murrelet abundance and distribution, and there is progressively less information towards the south end of this region (Carter and Erikson 1992). This area has distinct oceanographic, geographic, and nesting habitat characteristics.

Vessel transects at sea, marine radar techniques, and a compilation of observations from shore during the nesting season were used to assess the abundance and distribution of Marbled Murrelets in Sonoma, and Marin Counties. There was a north to south gradient of decreasing abundance through the region. Inland detections occurred in watersheds from Fort Bragg to Point Arena, but birds were only seen along Manchester Beach and around Pt. Arena at sea. Scattered detections of murrelets at sea, including 2 juveniles, occurred from Pt. Arena to Salt Point SP, with consistent sightings near the Gualala River. Irregular detections of murrelets around the Russian River, including 2 observations of juveniles, and radar detections inland, represent the southern limit of known nesting No detections of Marbled Murrelets have been recorded in Marin County during the nesting season in recent years, though suitable habitat appears to be available in parts of Pt. Reyes National Seashore and in Mt. Tamalpais State Park.

Population estimates for the Sonoma-Marin region are of about 50 birds. Failure to protect and improve remaining nesting habitat may result in the loss of this threatened species in a portion of their range.

Marine Bird Responses to the 2002/2003 El Niño 'Lite' and the 1998-1999 Regime Shift

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The El Niño of 2003 offered an excellent opportunity to examine seabird response to a warm water event during a "cool regime". In this paper, we examine the fecundity, recruitment, and diet from multiple seabird species breeding on the Farallon Islands in 2003. Since the PDO regime shift of 1998-1999, the productivity, diet and abundance of Farallon seabirds in the California Current have shown marked differences from the previous decades. Reproductive success and diet quality for most locally breeding species in central California has been very high, at levels not seen since the early 1970s. The later initiation of reproduction by Farallon seabirds in 2003 indicated a response to El Niño conditions in the winter of 2002-2003, but signals of this event vanished by May, relatively early in the breeding season. Nonetheless, 2003 was considerably less productive than the years 1999-2002. We contrast the demographic and foraging responses of Farallon seabirds in 2003 with previous "warm regime" El Niño events (1982-1983, 1992-93, 1997-98) as well as two previous "cool regime" events (1972-73, 1976-77). Many of these earlier events were considerably more severe, and affected demographic attributes (e.g. adult survivorship) that have immediate population-level consequences.

An Introduction to the Central California Ocean Observing System (CenCOOS)

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This presentation will include an introduction to the Central California Ocean Observing System (CenCOOS) -- a new regional coastal ocean observing system that is part of the national ocean observing system, the Integrated Ocean Observing System (IOOS). CenCOOS is a developing collaboration of approximately 30 marine research institutions, ranging geographically along the coast from California Polytechnic in San Luis Obispo to Humboldt State University in Arcata. Its goals include:

- Increased efficiencies of existing research projects and data collection;
- More integrated approaches to monitoring; and
- Enhanced utility of ocean observing activities for resource managers, policy makers, researchers, and educators.

This presentation will also include an invitation to researchers to participate in CenCOOS, as well as a solicitation of data and data product needs from resource managers, policy makers and educators.

Preliminary Results for the 2003 Invasive *Spartina* Monitoring Program

K. Zaremba

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Four species of non-native invasive *Spartina* (cordgrass) species, English cordgrass (*S. anglica*), dense flowered cordgrass (*S. densiflora*), salt meadow cordgrass (*S. patens*), smooth cordgrass (*S. alterniflora*) and its hybrids with the native Pacific cordgrass *(S. foliosa)*, have been found in the San Francisco Estuary and neighboring outer coast marshes. Atlantic smooth cordgrass and its hybrids are rapidly spreading and threatening to cause fundamental changes in the structure, function, and value of the San Francisco Estuary and outer coast marshes' tidal lands. Invasion impacts include possibly causing the extinction of native Pacific cordgrass, choking tidal creeks, dominating restored tidal marshes, and displacing thousands of acres of shorebird foraging habitat. In 2000, the California State Coastal Conservancy initiated the Invasive *Spartina* Project (ISP) to implement a long-term management program to arrest and reverse the spread of invasive non-native cordgrass species in the San Francisco Estuary. In 2000-2001 the ISP surveyed the San Francisco Estuary and outer coast marshes for the presence of non-native invasive *Spartina* (cordgrass) species and found 470 net acres of non-native cordgrass. The 2003 Invasive Spartina Monitoring Program objective was (1) to determine the rate of spread of non-native cordgrass by comparing the 2001 and 2003 aerial cover from a sampling of sites, (2) to determine the treatment efficacy for the 2002 control sites, and (3) to map the genetic surveys requested by landowners and managers. Field based methods enhanced with GIS were used to map and monitor the Bay and outer coast marshes. Preliminary findings from the 2003 Invasive Spartina Monitoring Program will be presented.

Notes:

Notes:

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